Draft Final Report

Identifying Determinants of Very Low Energy Consumption Rates Observed in Some California Households

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Disclaimer

The statements and conclusions in this Report are those of the contractor and not necessarily those of the California Air Resources Board.

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1 ABSTRACT

AB 32 and Executive Order S-03-05 call for carbon emissions reductions that, if booked as reduced energy use, can be roughly translated into an 80% reduction in average residential energy use by 2050. Considerable debate exists about the feasibility of such a large reduction. Yet a small percentage of California residential customers live at levels equal to this target. These "low users" can give policymakers insight into what is involved in living at the target levels. Because there is little information about these "low users" this study investigated the circumstances corresponding to electricity consumption levels in a sample of urban California households in the lowest decile. Primary data were generated through mailed surveys, telephone interviews, and a detailed customer dataset. Our questions focused on appliance ownership and use, building characteristics, demographics, attitudes, behaviors, incentive programs, and air conditioning. Very low consumption rates are real, and the distribution of low usage includes a cross section of customers broadly similar to the general population. By generating several profiles that capture different dimensions of the low user population this research identified key characteristics that combine low usage, diverse cooling strategies, an interest in energy upgrades, and high quality of life in multiple different ways.

2 EXECUTIVE SUMMARY

Background

California's AB32 and Executive Order S-03-05 require that the state reduce its GHG emissions to 1990 levels by 2020, and by 80% below 1990 levels by 2050. Although AB32 is primarily concerned with technical measures, ARB's responsibility to implement AB32 presents an opportunity to incorporate the results of this research study into the energy efficiency and conservation measures section of the law. One evocative way to interpret the 2050 target—to identify a pathway to compliance—is to apply it to (residential) electricity demand and ask whether a consumption level that corresponds to this future target currently exists, and if so what is involved in producing that result. This research is designed to explore the extent to which (very) low electricity usage in the current population could provide examples for an expanded customer outreach effort and a new perspective on the potential for the public to participate meaningfully in solutions to climate change. Very little research has addressed the question of what circumstances accompany very low residential electricity usage and who these people are.

Methods

To examine the behavior of low energy using households, we selected several samples from the general population of residential customers within the SMUD service territory using a master list of utility billing data. We took samples from the lowest decile of electricity consumption based on average monthly usage from 2008-2010. Households who did not live in the same residence for the duration of the study period were removed from the sample. Using the information in the billing data, we calculated summary descriptive statistics to identify trends in technical and socioeconomic variables within different subsets of households. We used truncated regression to examine the relationships between these variables and energy consumption in the general population.

In addition to the statistical analysis of the billing data, we conducted in-depth surveys and phone interviews in summer and fall of 2012 to gain insights into the specific circumstances and behaviors that result in very low energy usage. To accomplish these goals, we extracted separate random subsamples of renters and owners. We sent electronic surveys to 2,910 renters and 500 owners via email, while we mailed hard copies of the survey to 1,030 renters and 130 owners. We conducted phone interviews with a subset of owners who completed the survey and indicated a willingness to participate in an interview. The surveys and interviews were designed specifically to elicit information regarding behaviors and characteristics of households that were not available from billing data.

Results

This study has several implications for regulatory programs, and addresses misconceptions that have arisen around the topic of low energy use in the absence of a careful study. We found that households whose electricity consumption falls within the lowest decile are demographically diverse, showing similar variation in income, age, race and education as the general population. We derived six profiles of low users based on demographic variables as well as select answers to qualitative questions we asked in our survey to reflect this diversity. The six profiles include **Well Off and Energy Efficient** (18.5%), **Excellent Quality of Life** (24%), **Thermally Unflappable** (15.6%), **Ultra-low Users** (30.3%), **Sacramento Average** (22%), and **Unhappily Low Energy** (4.8%). Several profiles speak to the variation in how members accomplish their

low usage. Well-Off and Energy Efficient refers to those in the upper income, education, and home size tiers who indicated pursuit of energy efficiency improvements. Thermally Unflappable refers to those enjoy an average or better quality of life and who rarely or never use their A/C. Ultra-low Users are the users whose consumption approximates California's 2050 target. The last profile attempts to capture the folk theory about who would be found in the low use population using criteria such as house size, income and a statement about quality of life. Respondents' identification with their strategies for minimizing or avoiding A/C use contributed the most detailed responses in our surveys. The coincidence of its energetic and symbolic importance suggests that because low users so consistently exceeded utility recommendations that their messaging could be revised to include non-use. Building on the insights from the six profiles we identified four approaches to low usage, the first two of which are the most policy-relevant: **Behaviors and Energy Efficient**, **Behaviors and Non-Use**, **Just How It Is**, and **Constraints**. Additional research is needed to estimate the relative sizes of these categories, but our results suggest at least half of the lowest decile falls into the two first groups, whose engagement with the subject of energy is high. Having examined the lowest users and found many of them able to communicate their accomplishments and interest in the topic, we invite the ARB to consider the implications for policy and outreach related to AB32. If a subset of the population who started by following expert advice on energy matters and ended up achieving usage at these low levels, what could a reframing of the conversation to specifically encourage others to emulate these accomplishments achieve?

Conclusions

Considering that very low usage is something individuals with widely varying amounts of money, expertise, and dedication and from all walks of life have achieved, what steps could ARB take to encourage others to consider pursuing low usage, or reducing their consumption of energy? Rendering low usage visible is only the first step. Translating these findings into an outreach campaign is a logical next one. In light of AB32's goals and timetable, the opportunity to enroll the public as co-producers of a lower energy future seems very timely and promising. Our recommendations start by acknowledging low usage as a new and potentially significant fact that illuminates dimensions of the energy landscape that have remained in darkness, that were not considered to have any bearing on questions of energy or policy because no one looked there. Going beyond outreach campaigns, the fact of low usage could be leveraged into a more broad-based evaluation of the limits to home energy conservation and efficiency. Does the fact that low usage turns out to be real, and its practitioners come from all backgrounds, open up new ways of thinking about what is possible, how much we could individually and collectively reduce our consumption?

3 INTRODUCTION

Climate change is understood to require very large shifts in the ways we produce and consume energy. California laws (AB32 and Executive Order S-03-05) anticipate this by eventually requiring an 80% reduction in the absolute amount of greenhouse gas emissions within the state over the next few decades. How this is to be accomplished is not entirely clear, but California's policy guidelines for implementing AB32 rely heavily on technological advances, shifts in energy supply, upgrades to energy infrastructure, and improvements in the efficiency of end use devices and buildings (California ARB 2008, Long 2010, Energy and Environmental Economics 2009). Although most studies that explore options for meeting long term climate change objectives reflect this preference for technical solutions (Pacala and Socolow 2004), a few have identified a role for households (Dietz et al 2009). Given the scale and scope of meeting this challenge, why are households only occasionally recognized as having something to contribute to averting climate change? Why is the public left out of these conversations? How large of a role could they conceivably play in meeting these targets? What would we like to know about residential energy consumption patterns or behavior that could help answer these questions?

One reason energy demand may not be considered a reliable source of emissions reductions is that studies of energy consumption patterns tend to focus on population averages rather than inter-household variation, or the potential for large reductions. Averages reinforce the idea that energy consumption at prevailing levels is normal. Studying variation in energy consumption and the outliers, by contrast, can direct attention to both existing differences as well as illuminating potential lessons from a more heterogeneous view of energy use. Because we see an expanded role for households in climate change policy, we are interested in the degree to which variation in energy consumption has been recognized and studied, and, more importantly, what attention low users have received from this research community.

Variation in energy consumption across households has been studied extensively (Socolow 1978, Diamond 1984, Schipper et al. 1989, Hackett and Lutzenhiser 1991). Studies of variation in energy use direct attention to the role of social and demographic factors, but also point to the circumstances under which the social nature of energy consumption is revealed (Hackett and Lutzenhiser 1991). Variation among residential energy customers has also received attention in recent years via information-driven social norm messaging programs that target higher users through information mailed to customers, including a usage comparison across demographically similar households and a series of recommended actions (Dougherty et al 2011). Another outreach effort, pioneered by the Gainesville Regional Utility, puts customer usage information on the web for anyone to access. The expectation is that by encouraging customers to compare usage with anyone, the variation among households will motivate change (http://gainesville-green.com/). Others, such as Seattle City Light, have studied variation among their residential customers, as well as high usage, as a way to identify opportunities for large savings (Seattle City Light 2010).

Although low usage is obviously one component of the variation in energy consumption discussed above, members of the energy research community, as well as the rest of the energy sector, have paid less attention to low usage specifically. The work by Hackett, whose research into the energy usage of rural 'homesteaders' in Northern California (1980), and Johnson et al., who studied energy consumption among the Amish (1977), are two exceptions. Both studied

groups who were culturally and demographically homogeneous and whose identity revolved to varying degrees around a rejection of mainstream values, consumption patterns, and lifestyle.

The present project takes their work as a point of departure but inquires into the outliers within a heterogeneous urban population whose status as low users is not only invisible to members of the society within which they live, but also to themselves. They are not a group at all, but a statistical subset of the general population about whom we know almost nothing. The only distinguishing characteristic of this group is their low electricity usage. Jane Jacobs pioneered the study of what she called the 'unaverage' in her work on cities. She argued that unaverage clues are useful because statistical methods provide no information about *how* things are working within a system. Her interest in understanding the social dynamics that make cities work parallels our interest in the social dynamics that make low energy consumption possible. "City processes in real life are too complex to be routine, too particularized for application as abstractions. They are always made up of interactions among unique combinations of particulars, and there is no substitute for knowing the particulars (1961)."

There are several reasons to study these outliers. In the absence of a clear idea of how we can reduce our energy consumption (by 80%), studying those whose present consumption has the same GHG emissions as what policy prescribes for everyone in 2050 takes advantage of what we could think of as a natural experiment. Another reason studying outliers could help us advance toward this goal is that it presents an opportunity to increase participation in this unprecedented effort. Households who may wish to contribute in a manner commensurate with the scale of the objective should be given the opportunity to do so.

What we term a folk theory of who would be expected in the lowest decile (predominately poor people, those who live alone, or are never home) misunderstands both the population we hope to investigate as well as our reasons for doing so. While a higher proportion of poor people or people living alone may be found in the left tail of the population distribution, those "explanations" don't help us understand what is involved in living at these low levels of electricity consumption, or whether anyone is actively engaged in producing that result.

4 PROJECT OBJECTIVES

Since we knew so little about low usage and low users at the start of this research project, the chief objectives were to understand who low users are and what their lives entail that permits this low usage. What follows is a list of the questions that guide this research project:

- **Is very low electricity usage real?** Are households whose electricity consumption registers below the tenth percentile even occupied?
- **Who are low users?** How is the population similar or different from the general population? Are they satisfied with their quality of life at this low energy level or miserable?
- **What explains low usage?** What circumstances, patterns of behavior, strategies, and attitudes are associated with low usage? Concerted effort? Happenstance? Efficient technologies? Behaviors? Or are these customers simply poor and unable to afford higher energy consumption?
- **What insights from studying low users can inform policy?** Is it possible to take low user habits, priorities, strategies, and attitudes and craft a new approach to energy outreach? Are demographic similarities between low users and the general public adequate or helpful in bridging the gap, inspiring others to see their energy use in a new light?

Physical, economic, and behavioral explanations for low energy consumption patterns are frequently articulated but have not, generally, been tested. The list of hypotheses below is derived from a set of assumptions that experts and others make about who consumes very little energy and why. The data we collected in the course of this research allowed us to test these assumptions and accept or reject the null hypotheses.

1. Physical & demographic circumstances determine electricity consumption

- Common assumption/null hypothesis: Lowest users are small households living in apartments.
- Counter-hypothesis: Average-sized families in single family homes also appear in the lowest category.

2. Income

- Common assumption/null hypothesis: People use much less electricity because they are poor.
- Counter-hypothesis: Higher-income households appear in the lowest category.

3. Awareness

- Common assumption/null hypothesis: Low electricity consuming households do not think of their energy consumption levels as unusual.
- Counterhypothesis: Low electricity consuming households span a range of awareness of how non-standard their consumption patterns are.

4. Relationship between actions and expert advice

- Common assumption/null hypothesis: People use much less electricity because they have followed expert advice on energy matters.
- Counterhypothesis: Some low electricity consuming households have pursued strategies not advocated by experts or have ignored expert advice.

5. Natural gas substitution

- Common assumption/null hypothesis: people who use less electricity substitute gas for a higher than average share of their domestic tasks/appliances.
- Counter-hypothesis: Low electricity households use no more gas on average than the population as a whole, and may use less.

Profiles of low energy consuming households can supply examples for replicating conditions, strategies, and behaviors observed to correspond to very low usage. Descriptive information, emphasizing the priorities, struggles, and achievements of the people living in low-consumption households can be used to help raise public awareness and know-how through such programs as CoolCalifornia.org. Prescriptive information, which focuses on specific strategies that other households can pursue, will also offer crucial support to voluntary as well as regulatory initiatives. In both cases, research results will introduce concrete examples of much lower usage to policy makers and energy professionals who can translate factors that enable low usage into a series of actions, strategies, and recommendations.

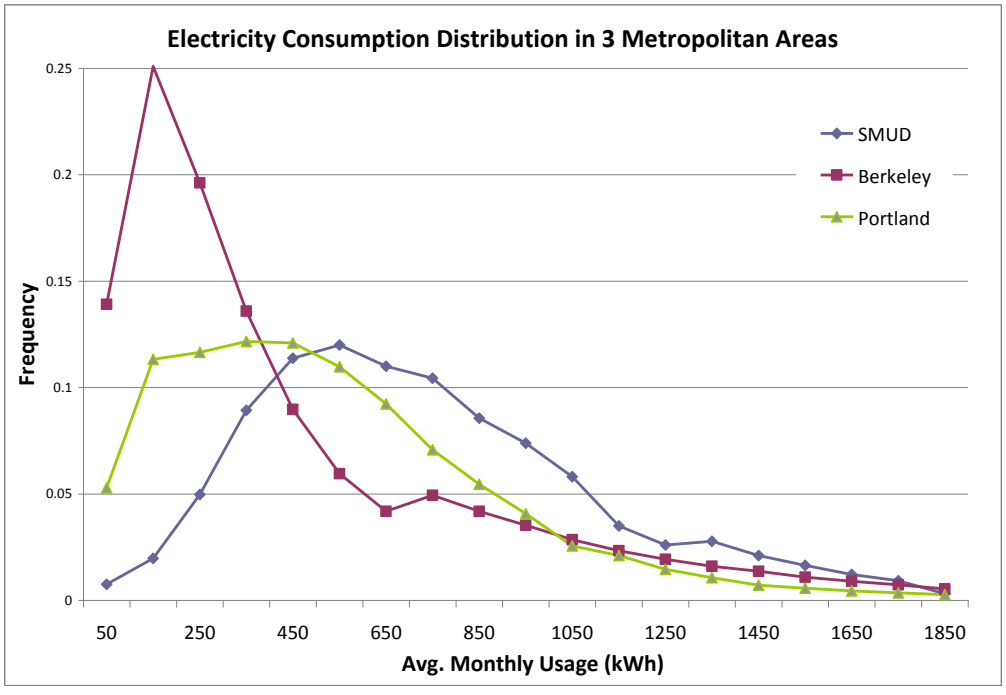
The household profiles generated by this research suggest the possibility of exploiting this very low usage for purposes of replicating low usage in households that are currently using much more electricity. In this approach, expert knowledge would be utilized not to prescribe standard bundles of technical solutions to everyone, but the lived experiences of low electricity households would be examined for strategies, circumstances, patterns of behavior, and other characteristics that correspond to low energy consumption patterns aligned with the mandates of California's Global Warming Solutions Act (AB32) and Executive Order S-03-05.

5 STUDY OVERVIEW

Materials and Methods

To survey or interview residential utility customers it is necessary to obtain permission from the utility. Residential customers in California typically use both natural gas and electricity and the initial version of this project was an extension of a long-standing data-sharing arrangement between the City of Berkeley and Pacific Gas & Electric (PG&E). However, in response to the Research Screening Committee's suggestions that a different, larger city would be more representative of the State as a whole the study site was moved to Sacramento. SMUD agreed to provide the dataset we requested, though as an electric utility, customer data on natural gas usage still needed to be secured through PG&E. Although negotiations with PG&E extended over several months, ultimately PG&E refused to allow us to use customer level data. Because the study was designed around low usage of electricity natural gas data were not essential, but a more complete picture of the low usage population's total energy budget would have allowed us to say a bit more about the potential for fuel substitution. We were able to obtain some data on natural gas consumption, appliance use, and ownership through our surveys, the Residential Appliance Saturation Survey, and the gas utility. These findings will be discussed at various points in this report, and offer useful context for understanding the primary subject, very low residential electricity consumption.

Figure 5.1: Distribution of residential kWh consumption in three West Coast cities/metro areas[1]

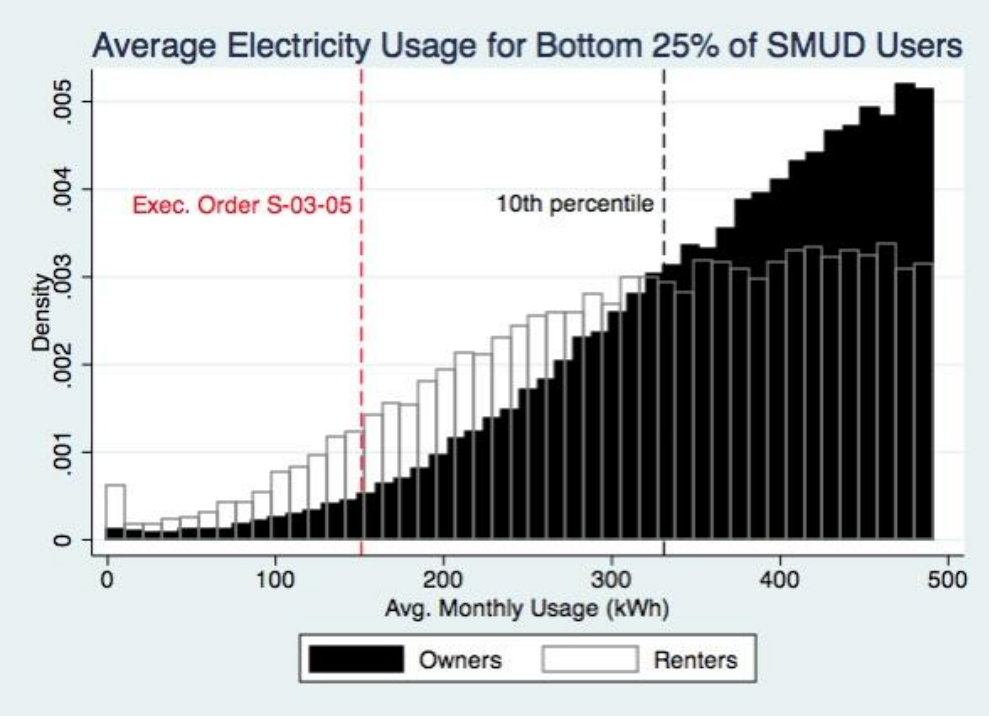


[1] Data for Portland are from PGE, and reflect only one SE Portland zip code; data for Berkeley are from PG&E and reflect the entire city of Berkeley. Both are from 2006. The curves represent the entire populations in each city.

SMUD maintains a database of its residential customers which includes a large number of fields describing the physical and demographic features of their customers' households in considerable detail. An extract of the bottom quartile of this dataset represents the foundation of this research project. After obtaining these data from the utility, along with summary statistics for the entire population, our first priorities were to (a) familiarize ourselves with the characteristics of this population, and (b) generate survey samples that would be representative of the portion of the population on which we were focusing our efforts: the lowest decile—those households whose electricity usage was lower than ninety percent of the utility territory's population.

The distribution of residential electricity consumption varies somewhat between jurisdictions (see Figure 5.1). Climate, building design, demographic variables, the history of electrification, and many other factors can influence the shape of this distribution. But in other respects the curves also share certain characteristics. The median consumption tends to be considerably lower than the mean because the right tail of the distribution, high consuming households, extends much farther out than the left tail, which tends to drop off fairly abruptly (Lutzenhiser and Bender 2010). Multi-family dwellings, typically apartments, are associated with slightly lower consumption, on average, than single family dwellings which are predominately detached houses. Figure 5.2 shows the distribution of residential electricity usage of the bottom quartile of customers for the Northern California utility we partnered with. Although data covering this quartile were used in the research to compare usage across various segments of the population, including to the entire population for which we obtained summary statistics from the electric utility, most of the research project is focused on the portion of the curves to the left of the dashed line denoting the tenth percentile (333 kWh/mo).

Figure 5.2: Average monthly electricity usage of bottom quartile of residential electricity customers



The sample provided by the utility had already eliminated customer accounts which had moved between January 1, 2008 and December 31, 2010, or who were no longer listed in the utility database as living at that address in early 2012, reducing the number of accounts in the sample by approximately forty percent. Examining the lowest tiers within the resulting dataset we came to the conclusion that the number of accounts suspected of being unoccupied that had survived that initial filter was quite small. The Statistical Methods section below describes how we approached the task of filtering out remaining unoccupied accounts.

Because we shared the Research Screening Committee's interest that a key output of the research be a series of profiles of low use customers whose demographic or other characteristics match those found in the general population but whose usage levels are starkly different, we found it necessary to focus our efforts on those households in the lowest decile. The only way to generate these profiles, and to develop case studies, was to focus on those customers whose usage distinguishes them as being in fact starkly different from the mean (or median).[2]

Data Sources

The utility statistics used in this research project included general population summary stats and account level data for the lowest quartile. Additional data for this project was taken from the 2008 SMUD Residential Appliance Saturation Survey (henceforth RASS). PG&E supplied aggregated data on residential natural gas usage for summer and winter.

Statistical Methods

- Phase 1 – Statistical analysis of energy consumption using utility billing data
    - Billing data contain detailed information on demographics and energy consumption for households in bottom 25% of electricity consumption (n = 83,561)
        - Age of household head
        - Ethnicity of household head
        - Household Income
        - Education of household head
        - Marital Status
        - Number of residents
        - Home age
        - Home size
        - Residence length

[2] The initial research proposal identified the zero to tenth percentile range as the most suitable sample for examining this low user population. In response to Research Screening Committee (RSC) suggestions this was adjusted to the 5th to 25th percentile range, with the goal of minimizing inclusion of unoccupied households on the low end, and to include a broad range of low users whose usage behaviors, physical circumstances, and attitudes were anticipated to be (more) diverse, and more familiar to the anticipated audiences of any recommendations that might be generated through this study. However, upon receipt of a preliminary dataset from the electric utility in February 2012, the research team discovered several things that caused us to readjust those parameters. First, the adjusted data range selected in response to RSC comments did not in fact include the low users, which for purposes of this research we defined as those whose usage is within 0.5 standard deviations of 80% below the 2010 median residential electricity consumption level for this utility service territory. Because the population of interest included occupied residences below the 5th percentile of electricity consumption, it was necessary to shift the lower bound of the sample back down again. The distribution of residential electricity consumption (See Figure 5.2) in this utility territory meant that usage levels above the lowest decile were insufficiently distinct from the mean to warrant inclusion in the survey population.

        - Owner vs. Renter
        - Participation in utility programs
        - Avg. monthly kWh usage (2008-2010)
        - Total kWh usage (2008-2010)
        - Ratio of Summer peak usage to non-usage (2008-2010)
    - Calculated summary statistics for demographic and housing variables for households in the entire sample and targeted subsamples (< 1%, 1-5%, 5-10%, 10-15%, 15-20%, 20-25%, renters, owners)
        - Compared patterns and distributions of these variables to patterns and distributions that exist for the entire utility population
    - Used truncated regression analysis to estimate the effects of demographic variables and physical housing characteristics on electricity usage

- Phase 2 – Renters and Owners survey[3]
    - Filter unoccupied households:
      Starting sample of 33,261 households in lowest decile;
      kept 27,025 households (14,627 renters and 12,398 owners) after filtering.
        - 3,934 dropped because the current address does not match the address in the data
        - 184 dropped because their avg. monthly usage is <30 kWh
        - 1,168 dropped because they are owners with length_res_yrs < 2.3
        - 950 dropped because summ_pk_2009 < .5 and summ_pk_2010 < .5
        - 56 solar PV customers dropped because their low usage was assumed not to be the result of consumption patterns as much as by on-site generation and net metering.
    - Randomly selected 3,940 renters and 630 owners from billing data and invited them to participate in an energy use survey
    - Designed hard-copy and electronic survey to elicit detailed information about energy infrastructure in the home and behavior around energy use
    - Conduct descriptive analysis to identify low user *profiles* and summarize energy using behavior amongst low users
    - Match survey respondents with billing data and conduct regression analysis to estimate impact of behavioral variables on energy use

In addition to the statistical analysis of the billing data, in-depth surveys and phone interviews were used to gain insights into the specific circumstances and behaviors that result in very low energy usage. To accomplish these goals, separate random subsamples of renters and owners falling in the 0-10th percentiles were extracted from the initial sample. Electronic surveys were sent out to 2910 renters and 500 owners via email, while 1030 renters and 130 owners were sent hard copies of the survey. Phone interviews were conducted with a subset of owners who completed the survey and indicated they would be willing to participate in an interview. The surveys and interviews were designed specifically to elicit information regarding behaviors and characteristics of households that were not available from billing data.

[3] The survey questionnaire and interview guide used in this study appear in the Appendix.

- Phase 3 – Phone Interviews (owners only)
    - Design brief (10-15 min) interview questionnaire focused on air conditioning behavior and recommendations for others with higher usage
    - Conduct phone interviews with respondents from owners survey who indicated they would be willing to participate
    - Conduct descriptive analysis of A/C use behavior and recommended actions for others whose energy use is higher.

Twenty one interviews were completed with homeowners drawn from the survey sample. The interviewees span five of the six profiles, and we have drawn on their responses to illustrate in greater detail what attitudes and strategies inform their approaches to using very little energy.

Results Summarized

- Phase 1 (Utility billing data analysis: lowest quartile)
    - <u>Econometric, average</u>
        - Households with higher incomes use more electricity
        - Households with younger heads of households use more electricity
        - Larger households (square footage) use more electricity
        - Households with more people in them use more electricity
        - Asian-American households use less electricity
        - Household heads with more education use less electricity
        - Despite the fact that households in the bottom quartile of electricity usage are somewhat poorer, smaller, less educated, and older, the distributions of these variables within the bottom quartile and the poor fit of the model suggest that other factors, such as behavior, may be an important contributor to low energy use.

    - <u>Behavioral, unaverage</u>
        - The focus on averages directs attention toward the familiar, common, unremarkable, and obscures what might be going on at the margins
        - The econometric approach assumes linear relationships between variables and doesn't say much about the mechanisms that lead to low usage.
        - But households found within the low use tiers are by definition outliers, unaverage; that is what makes them interesting to this research project. The *specific* behaviors, strategies, preferences, and attitudes that may not be widely distributed across the population coincide with low usage. It is these characteristics and the various combinations of them we wish to understand.

- Phase 2 (Survey analysis: lowest decile)
    - Response rates were 15.4% (renters) and 18% (homeowners).
    - Households spanning all demographic categories are represented in this low tier (income, education, age, race, household size, renter, owner-occupied)
    - A/C use behavior has a significant impact on summer peak electricity usage
    - Appliance ownership levels vary among low usage tier
    - Insights from long-form responses
        - Diversity of cooling strategies, tolerance for, and definition of, what is too hot

        - Strategies for managing summer heat (and winter cold to a lesser extent) represent not only lower usage but also serve as an index of the degree to which respondents' identify with or take ownership of the issue of energy
        - Cost savings a motivation to use little electricity for some but not others
        - Range of motivations, strategies, behaviors, as well as levels of self-awareness
        - Efficiency upgrades, changes to physical space
    - Behavior trends
        - Thermal management strategies rank very high
        - Typology of substitutions catalogues low use behaviors (See Table 5.1)
        - Roles of behavior and energy efficient technologies varies as does the degree of engagement and self awareness (see Table 5.2)

- Phase 3 (Phone interview: homeowners, lowest decile)
    - Cooling strategies are multi-faceted, involve diurnal behaviors (opening & closing windows, turning on and off fans), changes to physical parameters (tile floors, insulation, air sealing, solar shades, shade trees), and routines (avoid cooking indoors on hot summer days; spend more time outside)
    - Recommendations mentioned by interviewees
        - Open windows to take advantage of Delta breeze, use window fans
        - Window shades, air sealing, insulating
        - Turn things off when not in use (AC, lights, electronics, home office)
        - Avoid overheating, overcooling house

Demographics of the General Population, Lowest Decile, and Survey Respondents compared

This section details how the lowest decile compares to the general population, and also how well our sampling for the survey matches the demographic characteristics of the population from which it was drawn. Figures 5.3 - 5.6 compare all three populations with respect to the four demographic categories: income, education, age, and ethnicity. Renters and Homeowners are treated separately.

Utility customers in the lowest decile differ from the general population in a few minor respects. With respect to income, age, education, and ethnicity the overall distribution of the population whose electricity consumption falls below the tenth percentile is quite similar to the general population. Age, ethnicity, and education tracked each other very closely. Income is differentiated through five bins. In the case of the renter population in the lowest decile, their income matched the general populations' quite closely in four of the five bins, with the lowest bin (<$30K) diverging the most (46% vs 32%). In the case of homeowners, three of the five income bins were within 5%, but the lowest and highest bins are essentially reversed.

The two categories in which our survey sample did not match the lowest decile population very well were age and education. Our survey respondents were typically younger and better educated than the population we sampled. In preparing the survey we had compared summary statistics for households with and without email addresses and found a very good fit across all demographic categories. Because of this good fit we felt comfortable oversampling those households who had provided email addresses to the participating utility because electronic surveys tend to have higher response rates. We would modify the sampling the next time and

oversample customers who were older than 75 years and renters whose education had stopped short of 4 years of college, all else being equal.

Figure 5.3: Income distribution of SMUD general population, lowest decile, and survey sample

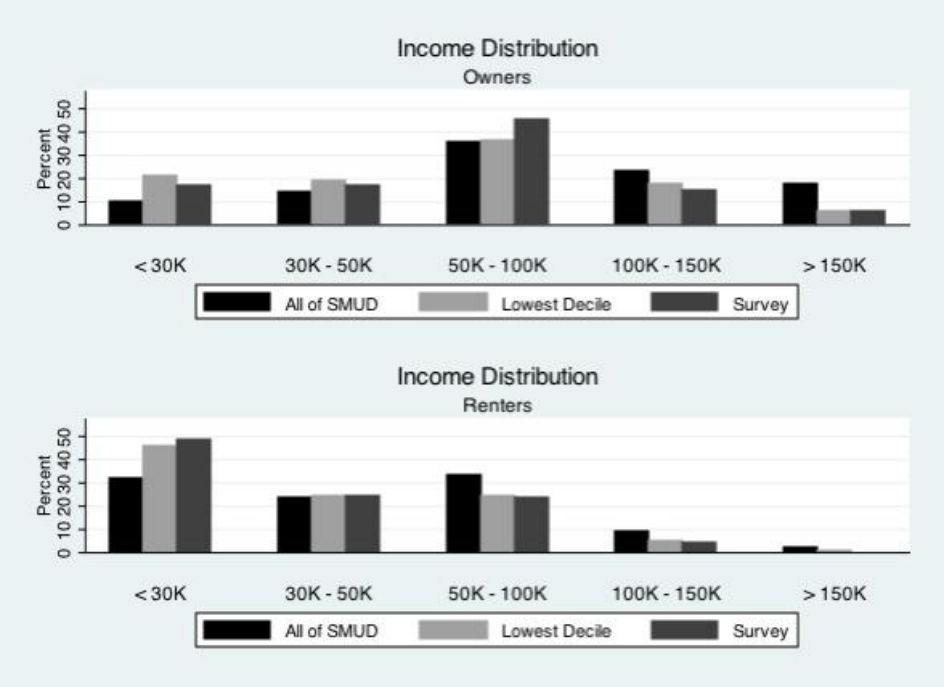
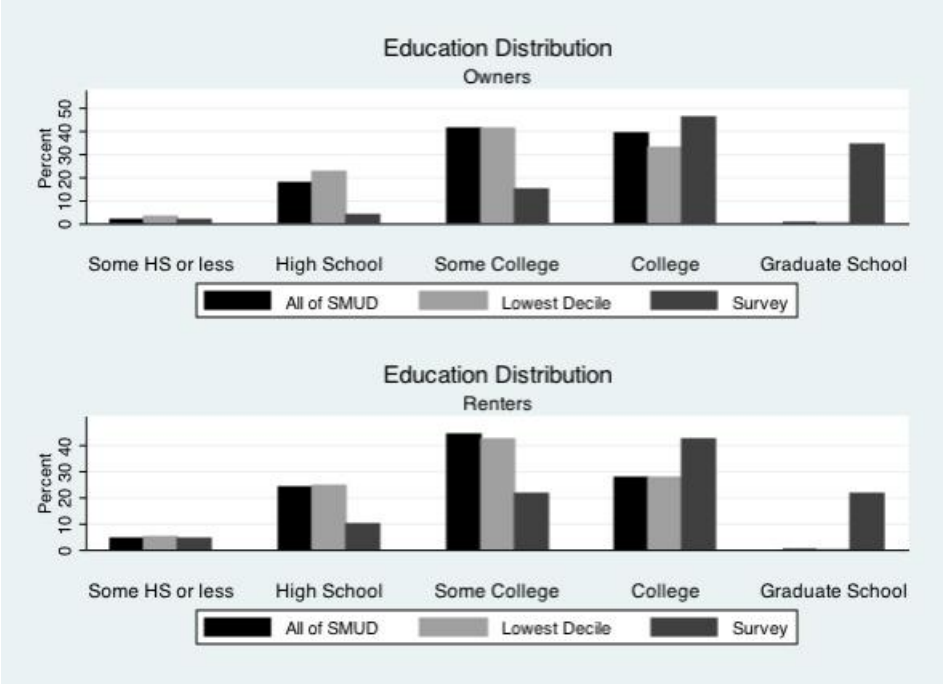


Figure 5.4: Educational attainment of SMUD general population, lowest decile, and survey sample



At least at this general level of population demographics, the similarity between the very low users and the general population is noteworthy. Hypothesis #1 which suggested "lowest users are small households living in apartments" would seem easy to reject on the basis of these demographic comparisons alone. We take this matter up in later sections of the report.

Figure 5.5: Age distribution of SMUD general population, lowest decile, and survey sample

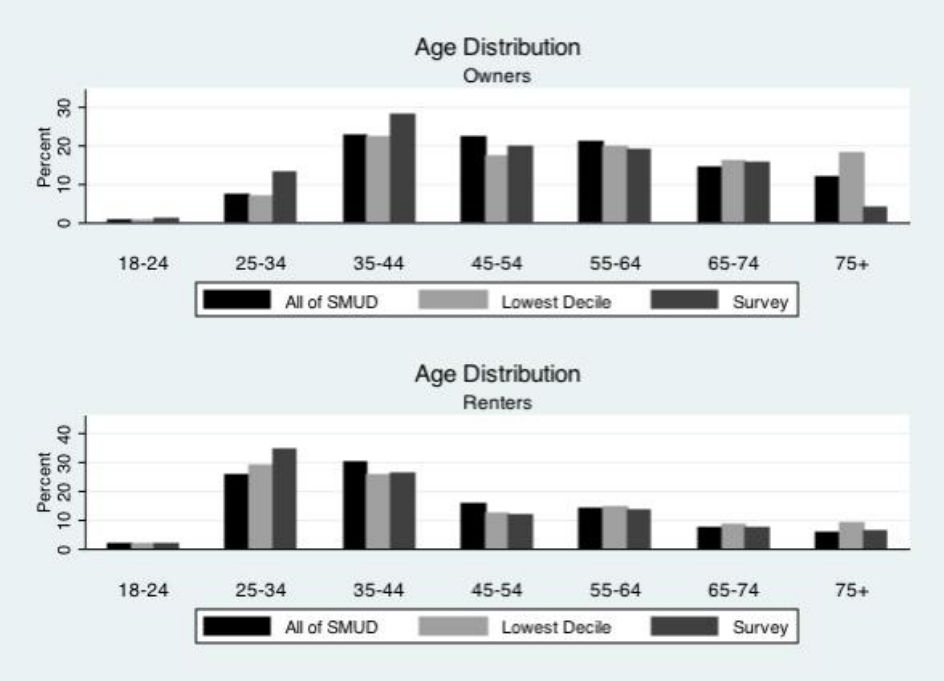
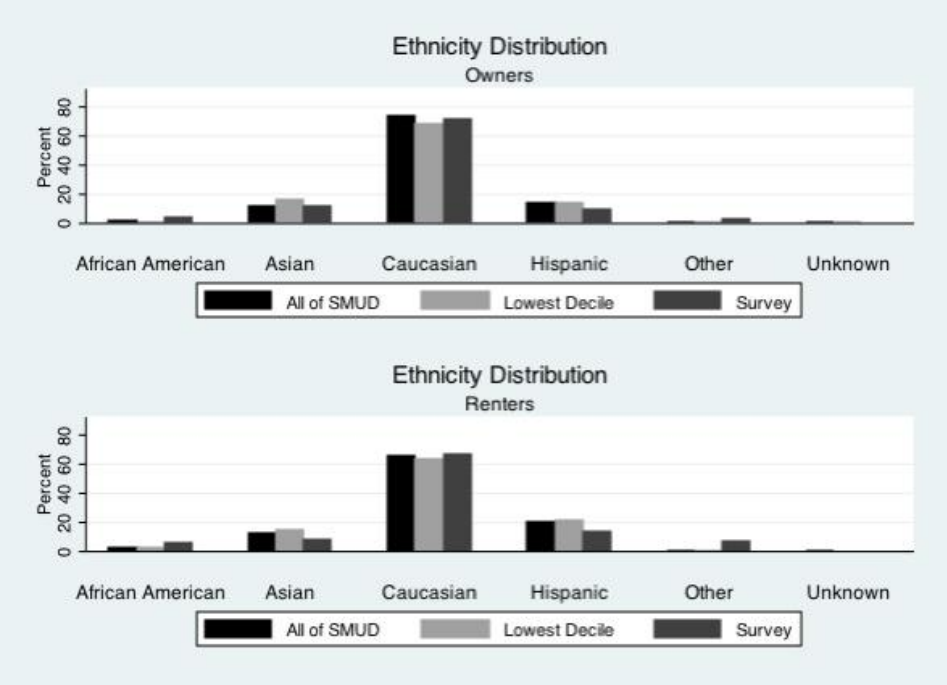


Figure 5.6: Ethnicity of SMUD general population, lowest decile, and survey sample



Demographics of Surveyed Population

The following six charts describe some of the salient attributes of the population of very low electricity customers who responded to our survey questionnaire. Where possible we have included a population average from the RASS for reference. We asked a series of demographic questions to verify the information we already knew from the utility dataset, or to obtain more fine grained information. All charts list owners and renter populations separately.

Figure 5.7: Income distribution of survey respondents

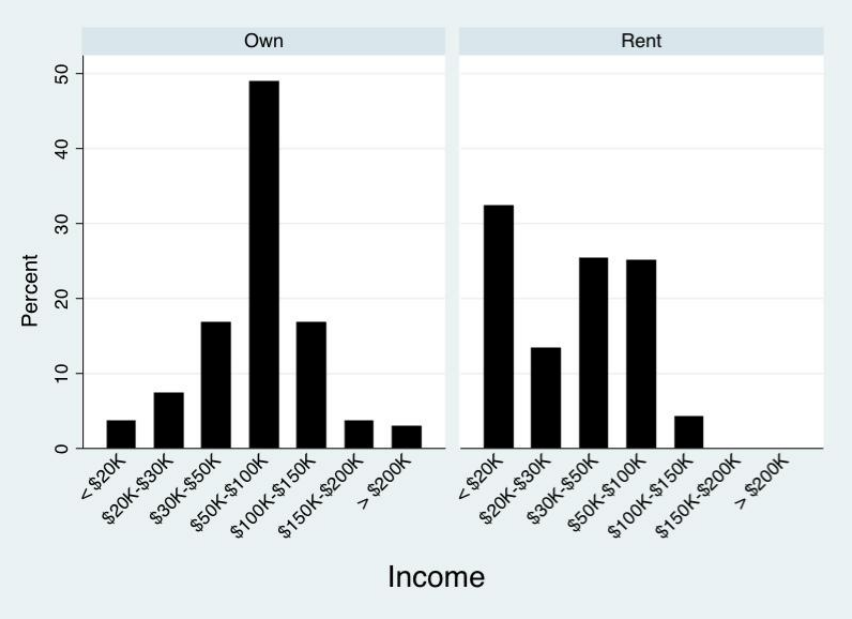


Figure 5.7 shows a more fine-grained division of income. Owner-occupied households are fairly normally distributed around the $50-$100,000 income bin, while renters are more spread out. The roughly one-third of renters whose income was <$20,000 is noteworthy. While this finding aligns with hypothesis #2 on income "people use much less electricity because they are poor," the fact that low users appear in most of the other income bins as well suggests any simple equation of low usage and low income is premature. Our counter-hypothesis was "higher-income households appear in the lowest category." Because of the exclusive nature of the null-hypothesis, we reject it, even as we acknowledge that poor renters are overrepresented in this sample relative to the general population.

The average number of occupants in the households that responded to our survey was 1.6 persons (Figure 5.8). This is significantly less than the 2.3 population average. We do not have figures that show the distribution of household size for the general population, but in California and the rest of the US a majority of households consist of 1 or 2 people. The high incidence of single people in this sample as well as the very small number of families is noteworthy. This dimension of the folk theory of who low users are may be the one closest to the truth.

Figure 5.8: Number of residents in bottom decile households

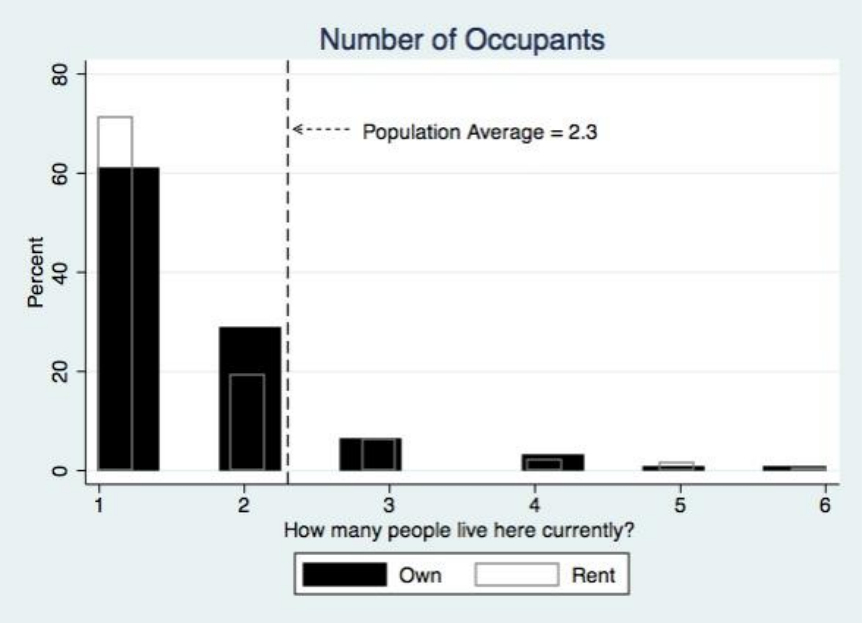
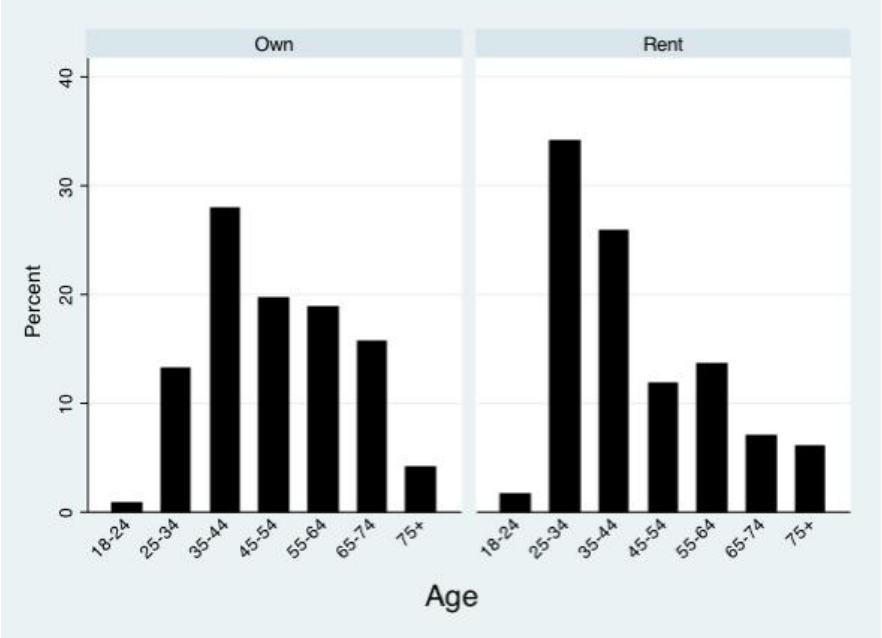


Figure 5.9: Age distribution of household head (bins)



As Figure 5.9 indicates, the distribution of homeowners and renters by age is not particularly surprising. Renters exhibit a peak in the 25-34 age bracket, whereas homeowners in our sample are slightly older and slightly more evenly distributed by age. Figure 5.10, which lists ages in years rather than bins shows how broadly distributed the age range of this population is.

Figure 5.10: Age distribution of household head (years)

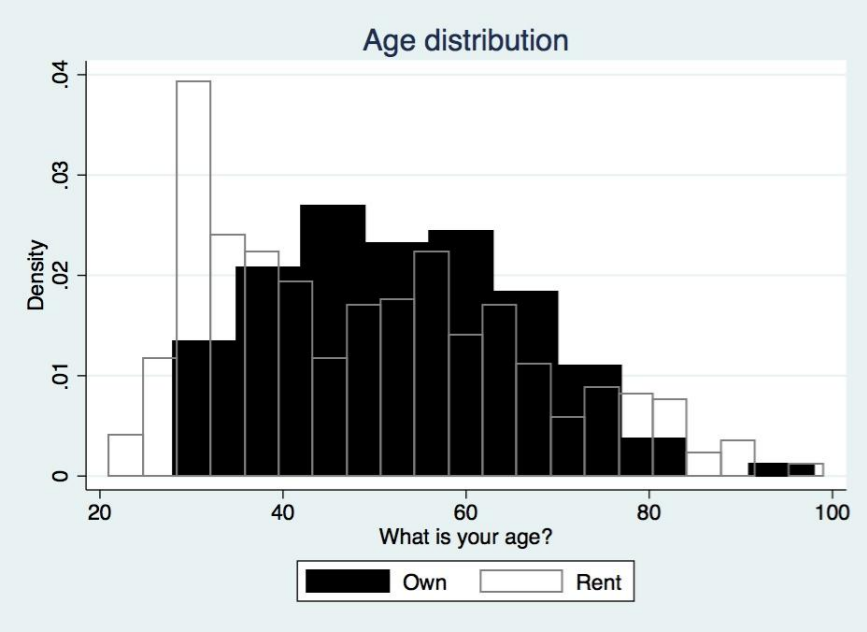
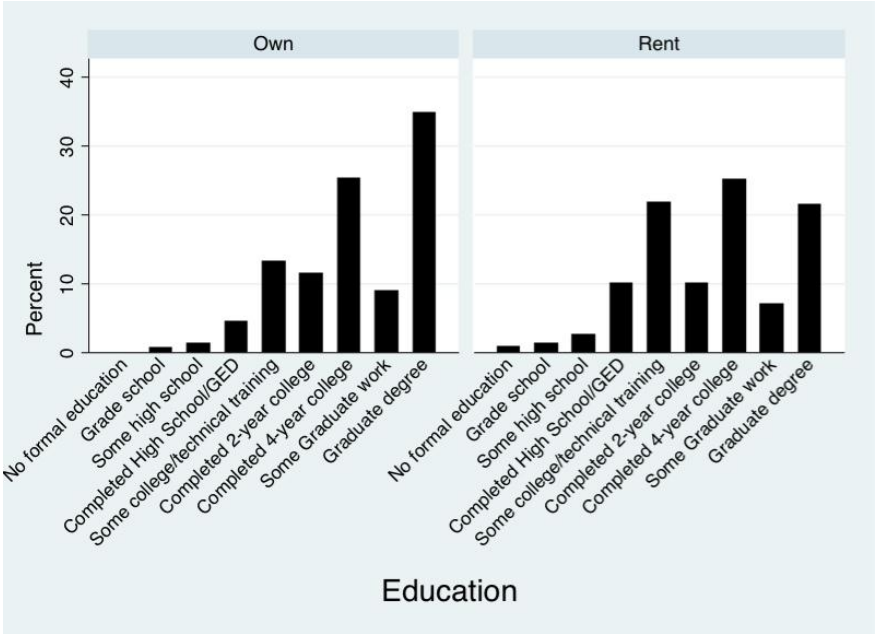


Figure 5.11: Educational attainment of survey respondents



We've already mentioned the degree to which our survey sampling shifted the educational attainment higher. Figure 5.11 includes all the educational categories we included in our survey. Home size, the topic of hypothesis #1 can be examined more closely in Figure 5.12. The square footage of the average owner-occupied home in our sample is very close to the population average, while the renter average appears to be a bit smaller. Because home size is logged in 500 sq. ft. bins we can't make any more precise statements than that.

Figure 5.12: Distribution of home size

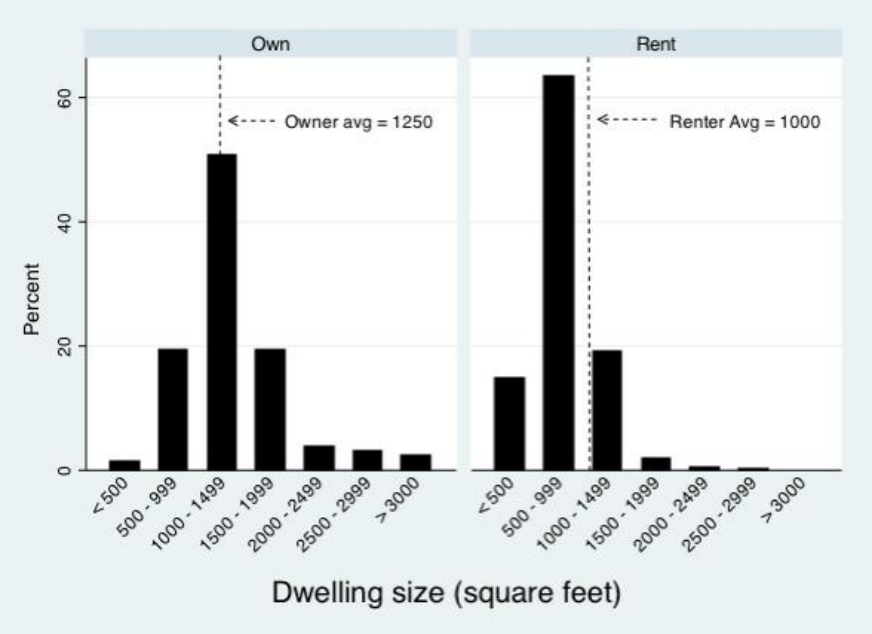
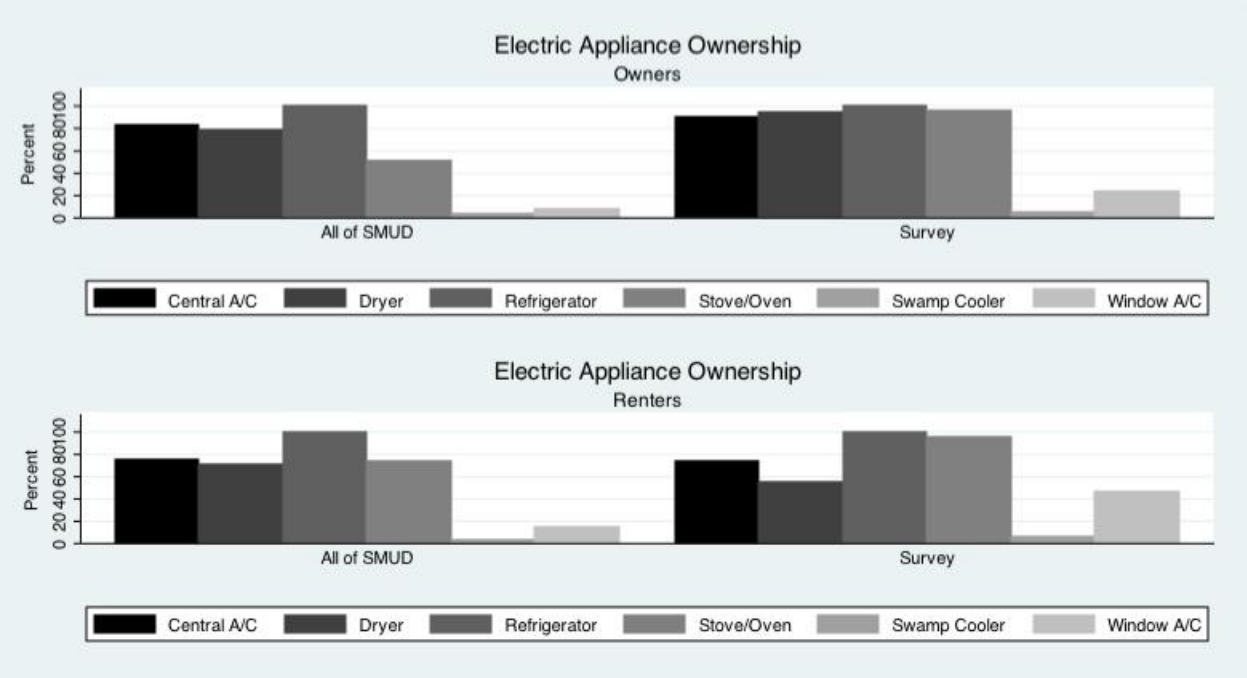


Figure 5.13: Ownership rates of major electrical appliances (general population data from the RASS, other data from our survey).



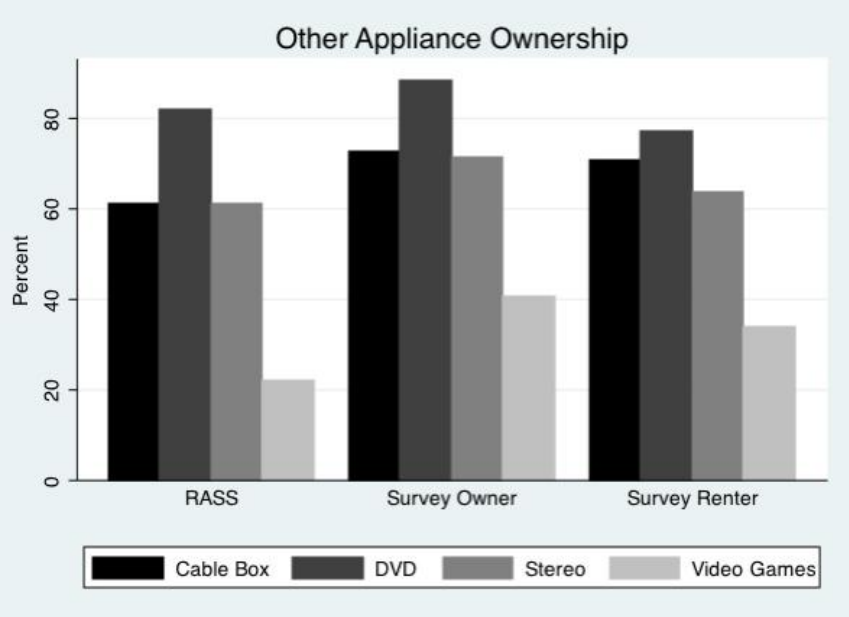
Electrical Appliance Saturations

Figures 5.13 and 5.14 compare appliance saturations noted in the Residential Appliance Saturation Survey (RASS) and in our survey of the lowest decile. Appliances are not a direct proxy of electricity use, but a household with a large number of appliances is assumed to have

the potential to use more electricity. The rise in so-called plug loads in recent decades is, furthermore, thought to be an important driver of increased residential electricity consumption (Sanchez et al. 1998). The fact that these low use households appear to own the typical suite of major and minor appliances, even at slightly higher rates than the general public, is noteworthy.

In our survey we asked respondents to identify what appliances they owned and used from a list of 27 electrical devices. The most common ones are listed in Figures 5.13 and 5.14.

Figure 5.14: Ownership rates of consumer electronics (general population data from the RASS, other data from our survey).



Natural Gas Appliance Ownership and Usage

Gas appliance ownership

Comparing gas appliance ownership among the general population and the survey respondents, our results suggest similar ownership rates overall (see Figure 5.15). Though the saturations of each appliance category differs somewhat, on balance the differences in ownership rates come very close to cancelling each other out. Surveyed homeowners have a slightly lower gas furnace and water heater saturation but are slightly more likely to own a gas oven and gas dryer. For renters the ownership rates on clothes dryers and furnaces are reversed, but similar for ovens and water heaters. Looking just at gas appliance ownership rates among the lowest decile, these do not appear to be responsible for lower electricity usage, something explored in hypothesis #5.

- **Hypothesis 5***: people who use less electricity substitute gas for a higher than average share of their domestic tasks/appliances.*

Figure 5.15: Prevalence of gas appliances in the home (All Owners data from the RASS, other data from our survey).

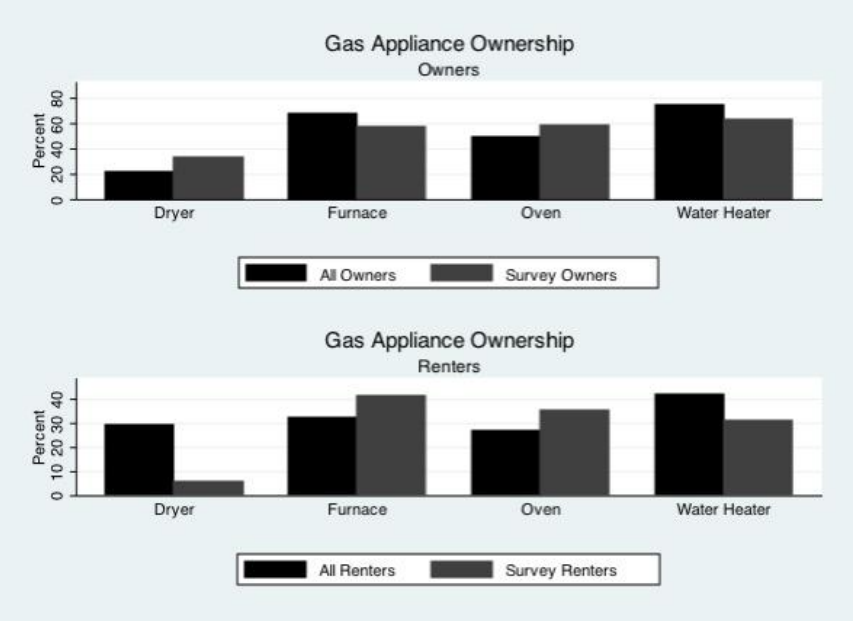
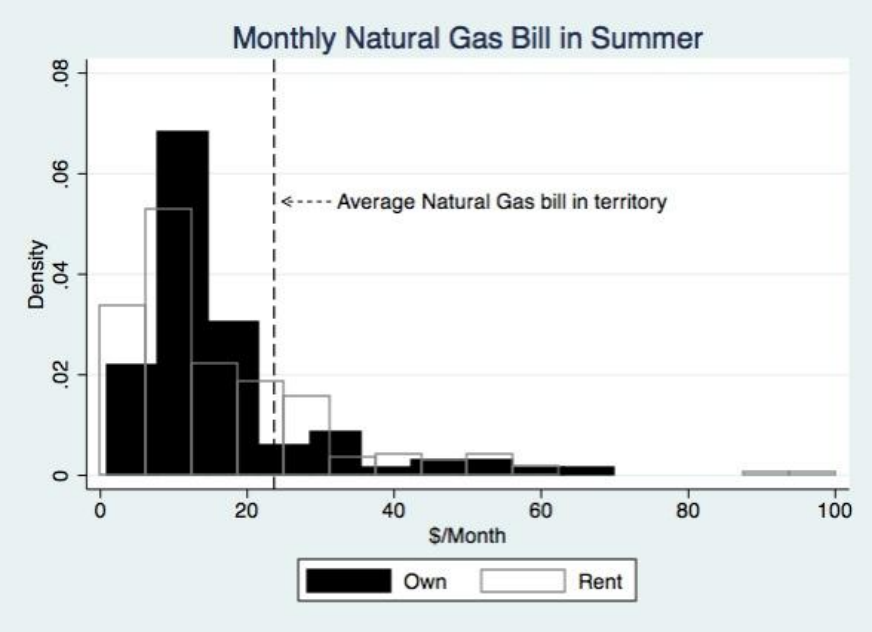


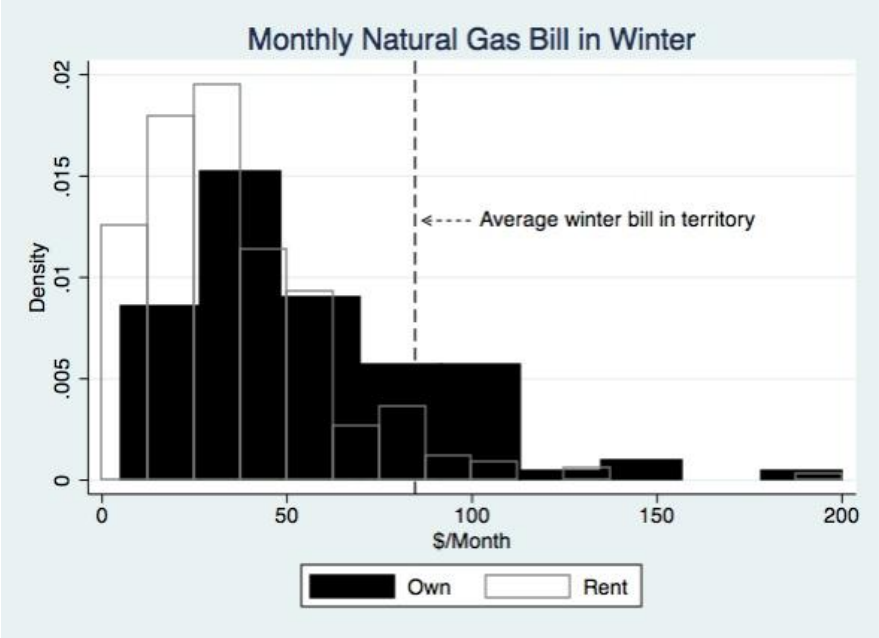
Figure 5.16: Distribution of typical survey respondents' natural gas bills in the summer



Gas usage

Data from the gas utility suggest that the general population (not differentiated by type of customer) uses an average of 19 therms/month in the summer, and 68 therms in the winter. Results from our survey suggest that on average renter households in the lowest decile use 14 therms in the summer and 29 therms in the winter, based on average reported bills of $17.01 and $36.06 respectively (see Figures 5.16 and 5.17). Homeowners in the lowest decile who responded to this question reported using an average of 10 therms in the summer and 43 therms in the winter, based on average reported bills of $12.65 and $53.29.

Figure 5.17: Distribution of typical survey respondents' natural gas bills in the winter



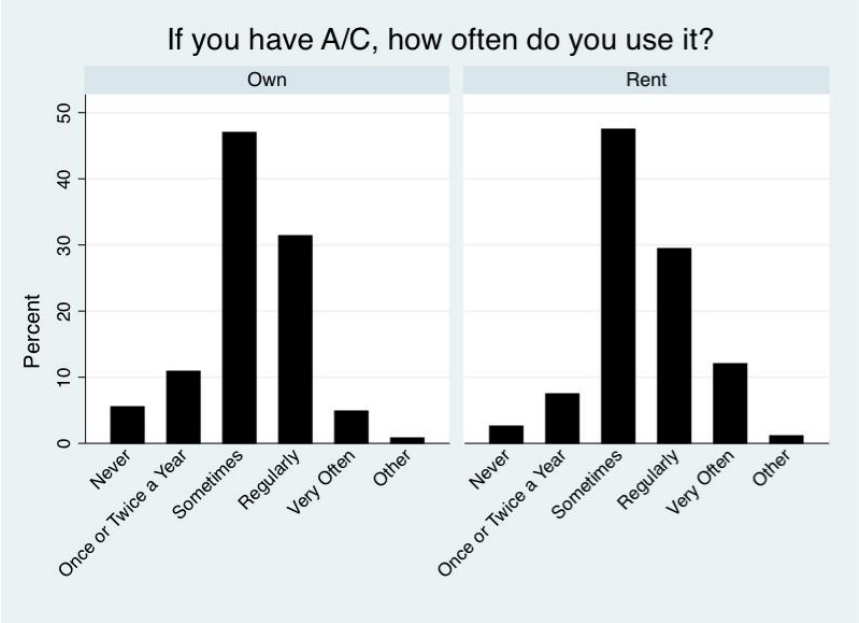
Although we were unable to directly compare the two surveyed populations to the aggregated (whole population) figures supplied by the utility, it is clear that both renters and homeowners who responded to our survey question about their average gas bill report lower average usage than the figure reported to us by the gas utility for the general population in both summer and winter.[4] We therefore reject the null hypothesis #5 (see above).

Air Conditioning

Air conditioning has already been discussed at various points in this report. Besides elevating the summer load in this Northern California utility territory, air conditioning also plays an important conceptual role in shaping how Sacramentans understand and think about their electricity consumption. Air conditioning, whether used within a given household or not, is a key point of reference in most energy discussions for the people we spoke with. Several of the open-ended responses to survey questions suggested this and so in our interviews we explored the topic in greater depth. When discussing low electricity use it is a topic that is impossible to avoid. It is understood to be both a chief cause of high bills, and also—for many of the low users—a point of reference in their pursuit of reduced electricity consumption.

[4] But since we don't know anything about the distribution of residential natural gas consumption in this population we cannot speak to the relationship of these lower consumption levels to the population mean.

Figure 5.18: Usage intensity of air conditioning (for households with either window or central AC)



Low users are not averse to using their A/C, as Figure 5.18 shows. But not all of them have air conditioning. Starting with central A/C, 10% of homeowners and 27% of renters who responded to our survey do not own one (see Figure 5.19). The saturation figures for window A/C are much lower. If we add the households who don't have either window or central A/C and those who say they only use it once or twice a year or never, we're close to 20% for renters and homeowners.

Figure 5.19: Air conditioning non-ownership

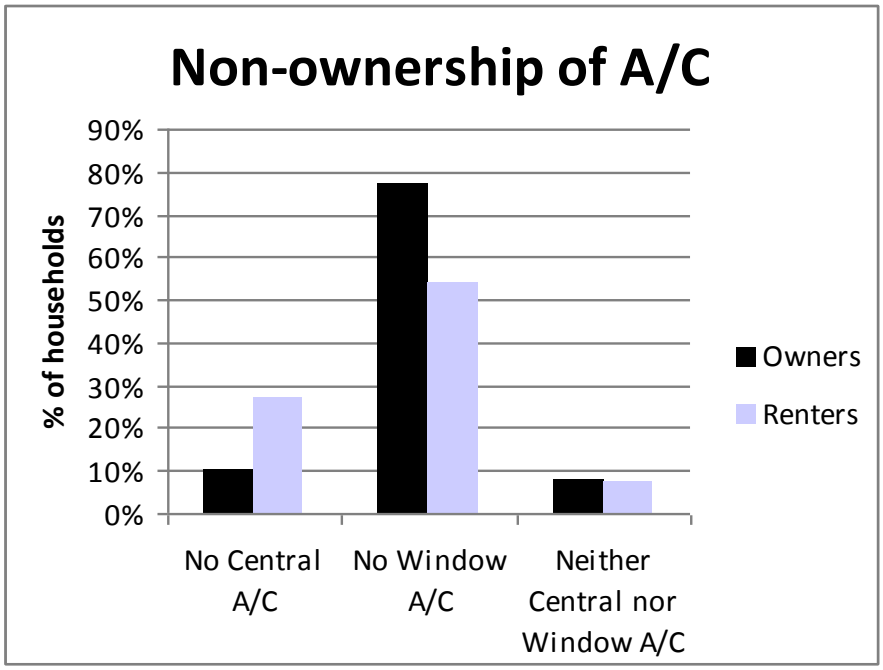


Figure 5.20: Self-reported air conditioning usage vs. total monthly kWh consumption

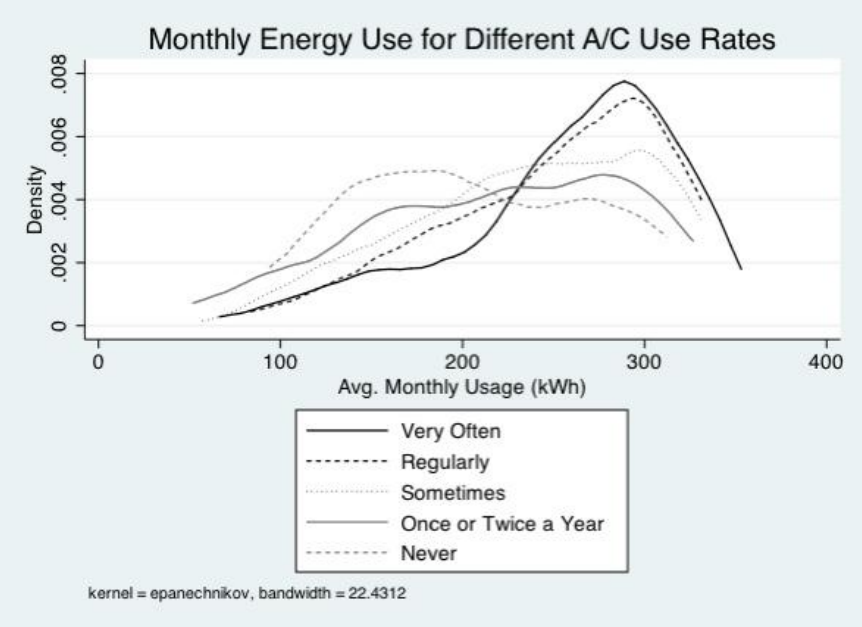


Figure 5.20 shows the degree to which those who report frequent AC use also have higher electricity consumption within this tier. Those who indicated relatively infrequent A/C use are distributed fairly evenly across the lowest decile range, with those who never use A/C are concentrated just below 200 kWh/mo and those who use A/C once or twice a year peaking about 100 kWh/mo higher.

Figure 5.21: Income distribution of households that do not use air conditioning

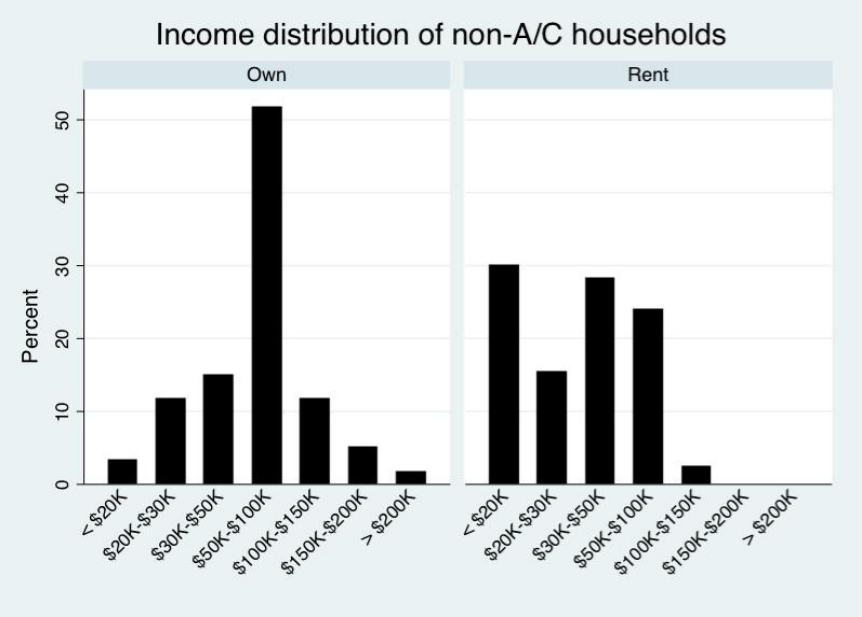


Figure 5.21 suggests that people who don't have or use A/C rarely (39% of our sample population) are not, as the folk theory of low users would have suggested, grouped off to the left in the low income bins but rather, at least for homeowners, symmetrically distributed about the $50-$100,000 income bracket. For renters, the distribution looks different, but if anything it is more evenly distributed across more income brackets. In light of this income distribution it is tempting to see A/C non-use as something the majority of households included in this chart have chosen rather than something they can't afford to run.

Figure 5.22: Summer peak loads for different air conditioning use behaviors

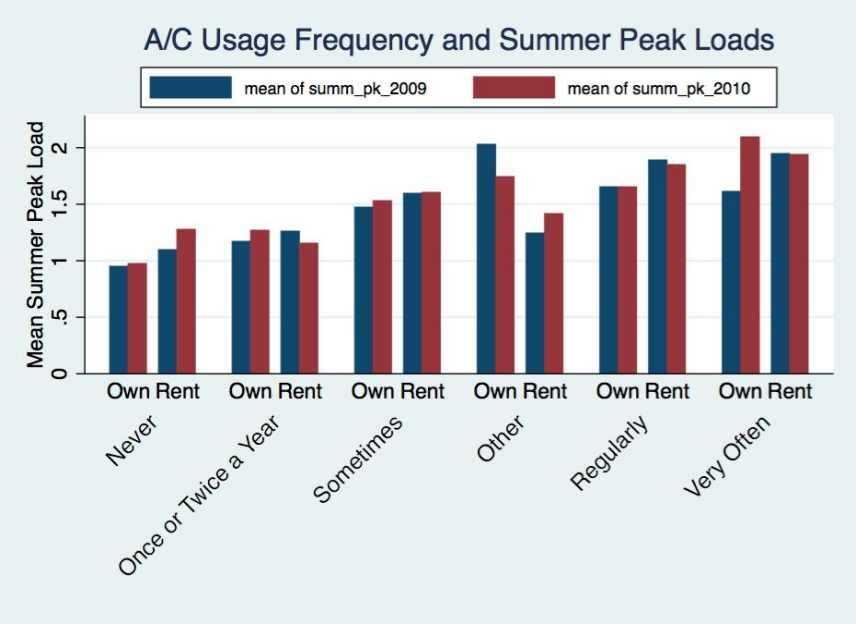
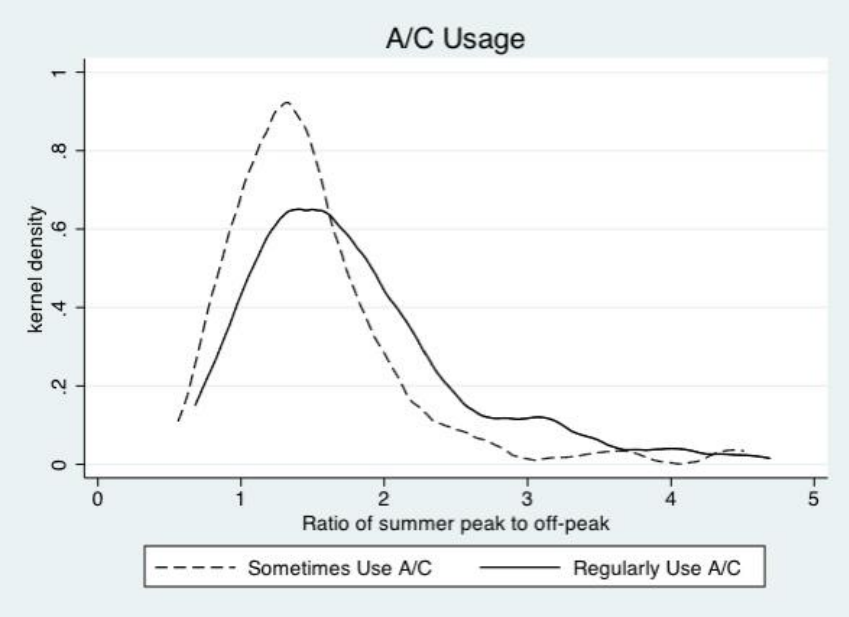


Figure 5.22 provides an opportunity to test the degree to which people's self-reported A/C use registers in terms of the summer peak to off-peak ratio. We assume that the summer peak is attributable to A/C use, and at least in this instance there seems to be a discernable gradient across these six categories of A/C usage frequency in relation to the summer peak.

Figure 5.23 is a very similar plot, but it shows the distribution of two of the six categories plotted against the peak to off-peak ratio. Responses about air conditioner use line up well with the data we have on the peak. A/C usage among the low use population varies considerably, and those who rely on it the least also tend to use the least electricity overall.

Figure 5.23: A/C usage frequency vs. summer peak loads (distribution)



Qualitative Responses: Behaviors and Constraints

The long form answers to several of the survey questions (15, 17, and 34) illustrate to what extent respondents recognize that their usage is low, how they think about their (low) usage, and how they explain it. We coded the answers to be able to organize these responses into categories. This was a multi-level task which yielded three types of responses:

1. Motivations or beliefs
2. Circumstances or constraints
3. Actions or behaviors

The motivations for using less energy included concern for the environment, being "conscientious," "conservative with energy," and frugal. Others ventured that "wasting water, gas and electricity is immoral," "I have a frugal mindset," "I live very simply but with quality." But these comments surfaced only infrequently. We didn't specifically ask about motivations or beliefs.

About one quarter (23% of owners and 24.5% of renters) mentioned at least one constraint in relation to their energy usage. We identified four constraints, listed in Figure 5.24:

- I live alone
- Not home much/work all day
- I can't afford to use as much energy
- I live in a small apartment

Because of the comparative nature of the question, most of the answers reflected respondents' sense of how they differed from their neighbors rather than an absolute condition or

even their own judgment of this circumstance. Not all who answered this question assumed their energy was lower, and some were certain it was the same as or higher than their neighbors'. Many of the respondents were familiar with the notion that a larger house, more people living together, or when someone works from home all correspond to higher energy usage compared to someone living alone in a small apartment and who leaves the house and goes to work every day. Figure 5.24 captures the extent to which respondents felt these circumstances applied to them, and had (or might have) bearing on their energy usage. A financial constraint was the least common of those mentioned in response to this question, and the issue is dealt with more in the section on quality of life later in this chapter as well as in Chapter 6.

Figure 5.24: Identification of constraints in relation to low energy usage among the lowest decile

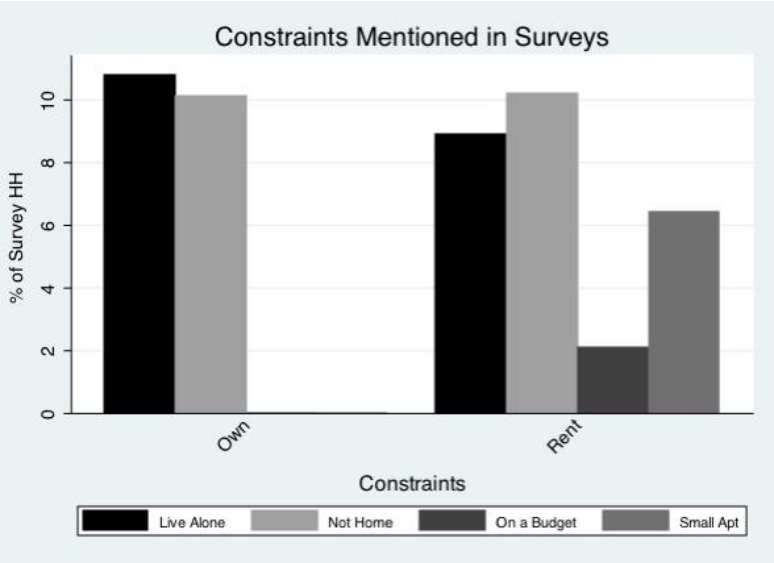
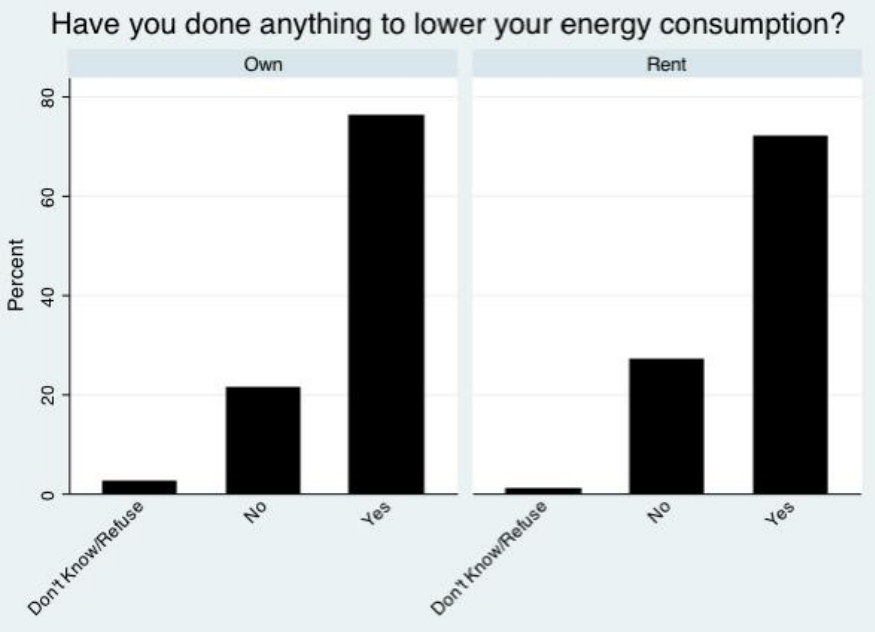


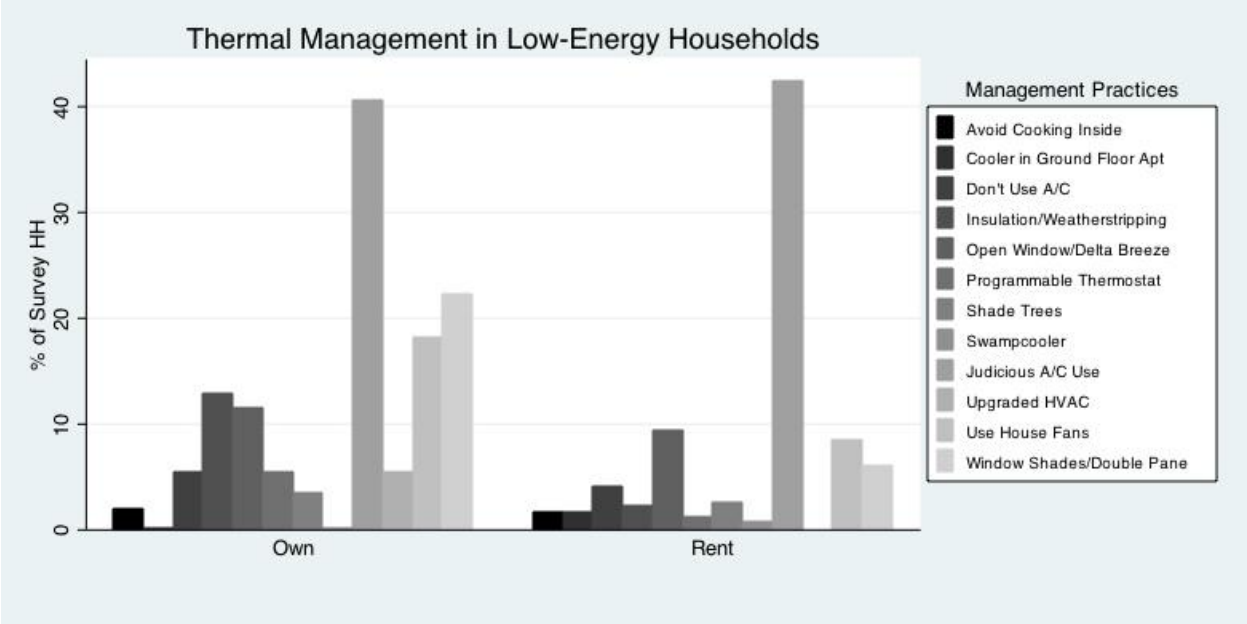
Figure 5.25: Taking action to reduce energy consumption



Returning to energy-relevant actions, we asked in our survey what—if anything—low usage customers had done to reduce their energy consumption. We didn't differentiate in this question between natural gas and electricity end uses or tactics. Figure 5.25 reveals that the majority of both renters and homeowners had done something.

The list of actions and behaviors mentioned in response to questions about what they did is extensive. The first set of responses we coded concern air conditioning and its alternatives, what we refer to as thermal management practices (Figure 5.26). Sixty-eight percent of owners and 54% of renters mentioned at least one thermal management practice. The most common response by far is labeled *Judicious A/C Use* in the figure below. This is necessarily a somewhat broad category in so far as most respondents recognize that when it comes to electricity consumption air conditioning is an important factor, one that comes to mind easily.

Figure 5.26: Approaches to dealing with Summer Heat



This response category reflects their recognition that the standard approach to cooling has energy implications, and that they are (or would like to be seen as) doing something about it. More specifically, the three answer categories grouped under the *Judicious A/C Use* heading are:

- Mention thermostat setting of A/C, e.g., 78F, 80F, etc.
- Run A/C rarely, only when necessary; never run when not at home, at night, etc.
- Run A/C less than the neighbors, only when it's 100F outside, etc.

Table 5.1: Code for questions yielding answers about thermal management strategies

1	window shades/double pane (shutters, film, drapes, curtains)
2	open window/delta breeze/screen door
3	thermostat setting >75F/rarely use A/C/run less than neighbors
4	use fans (whole house, attic, box, ceiling)
5	shade trees
7	avoid cooking inside/pilot lights off
8	swamp cooler
9	insulation/weatherstripping
10	cooler due to ground floor apt.
11	programmable thermostat
12	do not use A/C
13	upgraded HVAC system

The fact that roughly forty percent of respondents fit this category suggests that A/C is a component of their cooling portfolio (of varying importance as we'll see below), as well as, for many, a point of departure for other, associated actions and behaviors. The list of other practices is heterogeneous, including one-time physical changes to the building and it's surroundings (shade trees, weather stripping, insulation, double pane windows, upgraded HVAC, programmable thermostat), alternative cooling technologies (swamp cooler, fans), and manual interventions on, typically, a diurnal schedule during the summer (open/close windows and doors to take advantage of the Delta breeze, draw/close curtains, avoid cooking indoors on hot days). These actions frequently occurred together. (This and all subsequent quotes are taken from survey and interview responses. The number following the quotation refers to an identification number.)

> Programmable thermostat is installed and generally set higher/lower than average (typically 78 in Summer and 68 in Winter) Air conditioning is typically not turned on until internal temp reaches 78-85 degrees (i.e. it's generally only used on triple digit days) Make use of "passive solar" via decidious trees planted in front (South side) of house. Thermal drapes are used on South-facing downstairs windows; shutters are used on upstairs South & West-facing windows Utilize prevailing breezes, fresh air & ceiling fans/fans to maximize natural "air conditioning" as often as possible.

Dealing with the summer heat is obviously high on many low users' lists, but it is worth noting that SMUD mentions a list of *Summer Conservation tips* on its website that is quite similar:

> ***Summertime***
>
> *Conservation is most critical during the summer months, when air conditioners make heavy demands on our power supplies. The easiest way to keep your home cool is not to let it heat up in the first place. So you want good insulation, caulking and weather stripping. Shade trees, overhangs and awnings help, too. Beyond that:*
>
> - *Keep windows closed during the heat of the day, and draw blinds and draperies to keep the heat out.*
> - *Set the thermostat at 78 degrees or higher. You'll gain savings of about 5 to 10 percent on the operating cost of an air conditioner for every two degrees of cooling you're willing to give up.*

- *Change the filter regularly. An air conditioning unit with dirty filters can use 5 to 10 percent more energy.*
- *Use fans instead of the central air conditioning unit whenever possible. Individual fans cost about 90 percent less to operate.*
- *Adjust ceiling fans to turn counter-clockwise in the summer. (Usually this means that the switch on the fan should be in the "down" position.)*
- *Turn off unnecessary lights.*
- *Lay off appliances during hot afternoons and evenings. Many appliances create heat and moisture, making the air conditioner work harder. Limit use of ranges and stoves, dishwashers, dryers, washing machines, and other heat-producing equipment to early morning or late evening when temperatures are cooler.*
- *Rig a clothesline in the yard and give your dryer a break.*
- *Prepare cold meals such as salads and sandwiches. Cook hot meals only late in the evening, when it's cooler.*
- *If you have a refrigerator or freezer in your garage that isn't full, consider getting rid of it. These appliances tend to be older and hog energy.*
- *SMUD's Shade Tree program offers free shade trees for customers whose homes have an eastern, western or southern exposure that heats up during the summer.*[5]

The broad overlap of the two lists suggests that this population is familiar with SMUD's recommendations and also engages in many of the listed actions. Two actions, including the second-most common action mentioned by renters, however, were not found on SMUD's list, opening the windows to take advantage of the Delta breeze and not using the A/C at all.

Energy Behaviors

In their answers, respondents elaborated on their practices and the habits they've developed. The tension between a desire to conserve energy while remaining *comfortable* was evident in most responses that fall into the category of thermal management.[6] But often the listed activities encompassed a variety of end uses, purposes, and motivations. The following examples are typical:

> I am careful about using lights when there is plenty of out side light available and turn them off when not in use. I have replaced many of my lights with compact fluorescent light bulbs where possible. I try and control the temperature in my house by keeping it closed during the heat of the day while opening windows and running a fan to fully ventilate with cool air at night. This helps virtually eliminate the need for the air conditioner except during very hot nights when sleeping is difficult. Instead of using the heater in the winter I wear extra layers.

[5] https://www.smud.org/en/residential/save-energy/learn-energy-efficiency/conservation-tips.htm

[6] The survey was conducted during the summer which no doubt had some effect on elevating this dimension of their energy tactics.

> Turn off/unplug seldom used devices. Not use heater or AC until uncomfortable. (55/82F)
>
> i try to cook before noon, i line dry my laundry, i wash laundry in cold water, i use a fan instead of a/c when possible
> Strategic placement of fans for use with air conditioning. Use fans in morning to move cool outside air indoors. Use interior and exterior shades to reduce heating in summer. Computer and stereo connected to power strips so entire system can be turned off when not in use. Gas heater and stove lines are turned off in summer, my stove has 3 pilots that generate a lot of heat, so I usually get by with microwave.
>
> In addition to the obvious things, like turning off lights and appliances when not using them, or even unplugging them, we turn down the water heater in the summer, have LED lights in high traffic parts of the house, only use the window AC units at unbearable triple digit temperatures to cool down the room for bed time, nag the landlord for double pane windows, DIY insulate the house in the winter, cook efficiently with the oven and stove top (i.e.: reusing a hot pan or hot water that's already boiled)... Stuff like that.
>
> Use fans, not the air conditioner. Use sweaters, not the heater/furnace. Minimize use of washer/dryer and make it efficient (larger loads and hang clothes). Shorter showers. Turn off lights, turn off all appliances and unplug when not in use. Limit use when possible. Be conscious of use and limiting it when I can.
>
> All light fixtures now contain fluorescent bulbs. Most washing is done with cold water, and many items are line dried if possible. Lights are turned off in unoccupied areas of apartment. Window coverings are used during late afternoon hours (when sun shines in) during summer.

In attempting to accept or reject hypothesis #4, the answers to a question we asked about what if anything respondents had done to lower their energy consumption at home provide some guidance. On the one hand, we received responses like these:

> Instead of setting the thermostat higher in summer and lower in winter, I turn off the central heat/air at night. (2491)
>
> We only use the air conditioning when the temperature reaches triple digits, otherwise we put a bowl of ice in front of the fan to keep cool. For heat, our apartment is small enough to be heated when we use the over when we cook or bake. (1066)
>
> stopped using air conditioning (3575)

But others were clearly attentive to expert recommendations. As we saw above, the list of thermal management practices in many cases mirrors the list found on the electric utility's website and in their outreach materials. At other times the expert recommendations were mentioned alongside tactics not found on official lists.

> Walked through the PG&E web site and used their check list, replaced all light bulbs with energy efficient bulbs, use natural light more, wash clothes and dishes late at night, don't run the heater during the winter. (3729)
>
> I try to turn off all the appliances when not in use (ex. computers/printers/etc) rather than standby. I try to keep the airconditioner and heater off, and instead use a fan, blanket, or drink fluids. We put some energy lightbulbs in some of our lamps. We lowered the temp on the water heater.

In their answers to this question, respondents frequently mentioned switching to CFLs, but a similar number mentioned relying on natural light. Because respondents' answers to this

question exhibited such a diverse range of strategies, both expert-supplied as well as their own, we accept the counterhypothesis (below). While following expert advice is something a significant portion of low users take, it is often augmented by other, complementary, strategies. We accept both the hypothesis and counterhypothesis.

- **Hypothesis 4:** People use much less electricity because they have followed expert advice on energy matters.
- **Counterhypothesis:** Some low electricity consuming households have pursued strategies not advocated by experts or have ignored expert advice.

Lutzenhiser found similar behaviors in his study of responses to the 2001 California energy crisis. In certain categories, responses exceeded official recommendations, and perhaps more importantly registered on a different scale (2002). Particularly around thermal comfort, expert recommendations typically specify particular thermostat settings, conceived as being slightly higher or lower than the norm, e.g. *set thermostat to 78F, or 85F when on vacation*. Many utility customers, however, both in Lutzenhiser's study and in ours, often simply turned off their A/C rather than following the advice to change the thermostat setpoint.

We encountered this in the context of heating and cooling, but also in terms of many other appliances that were turned off for the season, or unplugged when not in use (presumably to reduce standby losses). This suggests a more active mode of interacting with energy using devices, where control is exercised outside of the script suggested by the thermostat or even, in the case of phantom/standby power concerns, the on/off switch.

While the goal (cooling a hot interior) may be appreciated and accepted by these customers, if perhaps for less time or to a lesser extent than the neighbors who "run their ac all the time even when no one's home," they often draw the line at giving over control to the thermostat. As (Kempton & Krabacher, 1987) observed, it is not at all uncommon for people to interact with their thermostats in ways not intended by the manufacturers. Sometimes their decision rules about when and why to adjust the thermostat even elude energy researchers. The interviews which focused on summer cooling strategies bore this out as well.

Substitutions: Cataloguing Strategies and Behaviors

Official suggestions about how to find a balance between comfort and energy usage make assumptions about how far the public can be encouraged to diverge from what is considered normal practice. Thermostat set points, using curtains to keep the sun out, and relying on fans to complement the air conditioner are typical, and we've seen that many in the low use tier follow these suggestions, constructing more or less elaborate regimes using these and other tactics that produce conditions they find acceptable or even pleasant. But some of the low users have redefined what is normal. Their patterns diverge from—go beyond—the standard protocol. By focusing their attention on how to minimize electricity consumption, experimenting, perfecting their approach they have arrived at solutions that lie outside the range of official suggestions. Building on a standardized protocol, their solutions tend to incorporate or utilize particular features of their houses, exploit building orientation, shade, conform to domestic routines, etc. By striking out on their own, exceeding official suggestions, they have discovered or invented habits and patterns that allow them to live comfortably while relying far less or not at all on air conditioning, or other end use devices.

While this effort requires a certain level of commitment, time, and the resources to experiment with different strategies, materials, and routines, many of the low users we

encountered seemed pleased with their achievements, proud that in a very palpable sense what they were doing 'worked.' For many of these individuals not having or using A/C is not viewed as a limitation but an opportunity, a matter of pride, even. Many of them could afford A/C but they prefer to solve the problem another way.

> This is a 1910 Victorian, and it's got double hung wood frame windows. So, in the summer, in the evening, I open the windows from the top and the bottom. I open the front door and the back door, which I rearranged a little bit when I bought the house so they're in alignment with each other. And there's a hallway that connects them, and the rooms are off the various hallways. So, in the night time, I open up, and I let the breeze come through the windows and the doors. It cools the house, and sometimes I leave it open all night long, and it charges the house, it's cool. So I have lath and plaster walls, which serve as thermal mass, so they get charged at night with cool, and it lasts most of the day on a hot summer day. So when it's a hundred outside, it's usually eighty or less in here. And then, you know, when it starts feeling warm in the evening, that's when I know it's cooler outside, it's time to open up and reverse the situation. So, thermal mass gets charged with heat during the day a little bit, and then it discharges it at night when that wind, the air is blowing through and removes some of the heat. I know I'm unusual; this not the normal way that people live. (152)

Table 5.2: A typology of substitutions: functional equivalence and low use pathways

Parameter	Principles	Examples	Result
Space	Match scale to task	Space heater vs. furnace; microwave vs. oven; el. blanket vs space heater, fan vs. A/C	Reduced electricity
	Optimize physical space	Insulate, keep sunlight out, open windows	
Time/ Scheduling	Operate for shorter duration/ less frequent	Manual AC control; use timers; power strips, turn off (when gone, at night, not in room), shift to off-peak,	
	Run only full loads	Dishwasher, laundry, shower sequentially	
Sufficiency	Adequacy	Wash laundry cold	No electricity for that function
	Manual alternative	Line dry clothes	No electricity
	do without	Get rid of AC, TV, clothes dryer	
Efficiency	Upgrade to more EE version	Replace A/C, windows, CFLs, appliances	Reduced electricity

The strategies low users pursue in the course of their daily lives include a heterogeneous mix of different behaviors, adjustments, decision rules, and priorities. Table 5.2 below is intended to provide a framework within which to locate many of these diverse actions, a way of ordering them. Most energy relevant behaviors involve a device of some kind: a light bulb, an air conditioner, a dishwasher, a TV, a clothes line. Because these devices are heterogeneous in function, energy use, and cultural importance (to name just a few) the scripts people use or have invented for them are not always easily categorized. One way to approach this is to identify the principles these diverse strategies reflect. Table 5.2 links actions with principles allowing us to consolidate them into a smaller number of categories. All the examples are taken from low user's responses to our survey or interview questions.

While choosing to use a space heater instead of turning on the furnace may require less energy, it also reflects a conceptual model of how different energy technologies are related and potentially substitutable. Underlying this view of substitutability is a hierarchy that sees functional equivalencies with differing energy implications. These tactics represent different levels of commitment to reducing energy consumption. While some of the low users may engage in all of these, others may have pursued none of them. Most are somewhere in between those extremes, choosing a path that reflects a balance—between comfort and energy, or between maximum household-level energy reduction and devoting time and energy to other pursuits.

Types of Low Users

Once we established some relationships between different styles of how people interact with their energy hardware, it was only a small step to outlining a set of categories that attempt to classify the types of low user according to their approach to energy conservation. Table 5.2 is not the definitive treatment of the subject, based as it is on incomplete data, but it does reflect a broad set of distinctions that our research has revealed.

Building on the insights from the typology of substitutions (Table 5.2), a matrix that organizes energy behaviors according to eight principles, including doing without, running only full loads, matching the scale of the device to the task, and upgrading to a more energy efficiency version, we identified four approaches to low usage (see Table 5.3), the first two of which are the most policy-relevant: **Behaviors and Energy Efficient**, **Behaviors and Non-Use**, **Just How It Is**, and **Constraints**. Additional research is needed to estimate the relative sizes of these categories, but our results suggest at least half of the lowest decile falls into the two first groups, whose engagement with the subject of energy is high. The first category **Behaviors and Energy Efficient** includes people who follow expert advice on energy efficiency, augmenting the investment in technologies or building improvements with more or less elaborate routines and behaviors. The second, **Behaviors and Non-Use** go about it in a slightly different way. Because they are content not to have so many appliances or other electrical devices, or to use them less frequently, they manage to use little without investing in upgrades. The third category **Just How It Is** use little energy without recognizing it as exceptional. Consequently they have little to say about their efforts. The fourth category **Constraints** includes people whose usage is low not because they aspire to it but because one or more constraints, including not being home much, living alone or in a small apartment, or the inability to afford to spend more on energy, keeps their usage low.

Table 5.3: Types of Low Users

Types of Low Users	Description
Behaviors + EE	actively engaged, self-motivated (varying combinations of behavior and efficient technologies)
Behaviors + Non-Use	actively engaged, modest lifestyle, prefer to have and use less stuff
Just How It Is	no special efforts and little self-awareness about energy
Constraints	wouldn't mind consuming more energy if they could

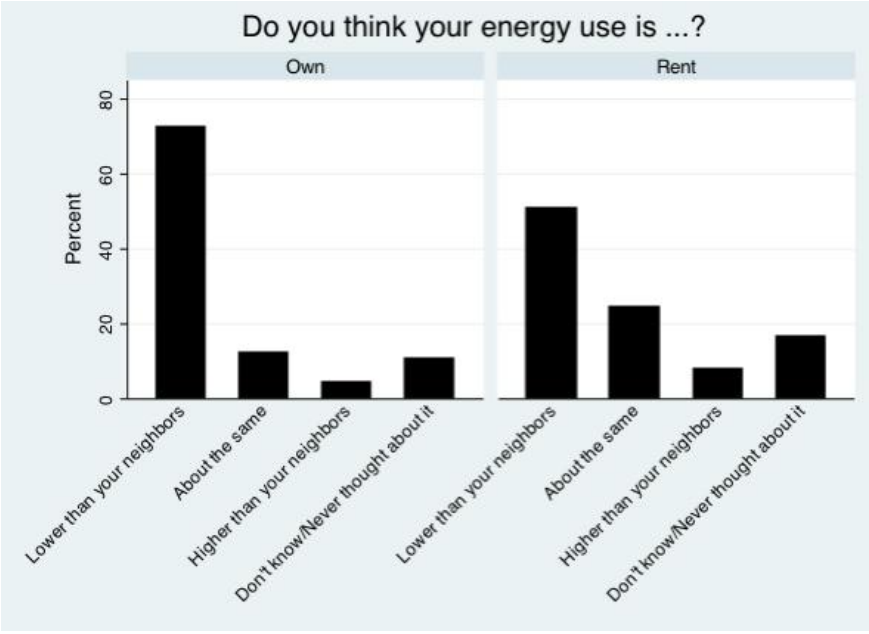
Thinking and Talking about Energy: Awareness, Conversations, Advice

Electricity is rarely used for its own sake. The kinds of services that electricity provides are intertwined with our domestic routines, habits, social norms related to comfort and convenience, and a great many other patterns of behavior. The relationship between fuels and social norms and behavior are complex and have co-evolved (Shove 2003). In our survey we asked a series of questions about how respondents think and talk about energy. These questions are intended as indirect measures of the degree to which people living at these low levels of electricity usage are consciously engaged in producing this low usage or, to the extent low electricity consumption was a conscious goal, are aware of their 'success.'

Although we tried to avoid phrasing or question sequences that encouraged respondents to tell us what they thought we wanted to hear, on some of these questions this possibility cannot be ruled out. The answers to these three questions suggest that only a slight majority of respondents who rent recognize that their energy use is lower than their neighbors, while closer to seventy percent of homeowners recognize this.[7] Hypothesis #3 addresses the level of awareness low users exhibit about their exceptional electricity use levels. Figure 5.27 suggests we must reject the null hypothesis.

- **Hypothesis 3**: *Low electricity consuming households do not think of their energy consumption levels as unusual.*
- **Counterhypothesis:** *Low electricity consuming households span a range of awareness of how non-standard their consumption patterns are.*

Figure 5.27: Perceived energy consumption relative to neighbors



Respondents typically think about energy quite a lot and although they claim to talk about it with others (only) sometimes, most were happy to describe their interactions with others on the subject of energy. These conversations range across a lot of territory.

[7] It is of course possible that their energy use is not lower than their neighbors.

Figure 5.28: Salience of energy consumption in the home

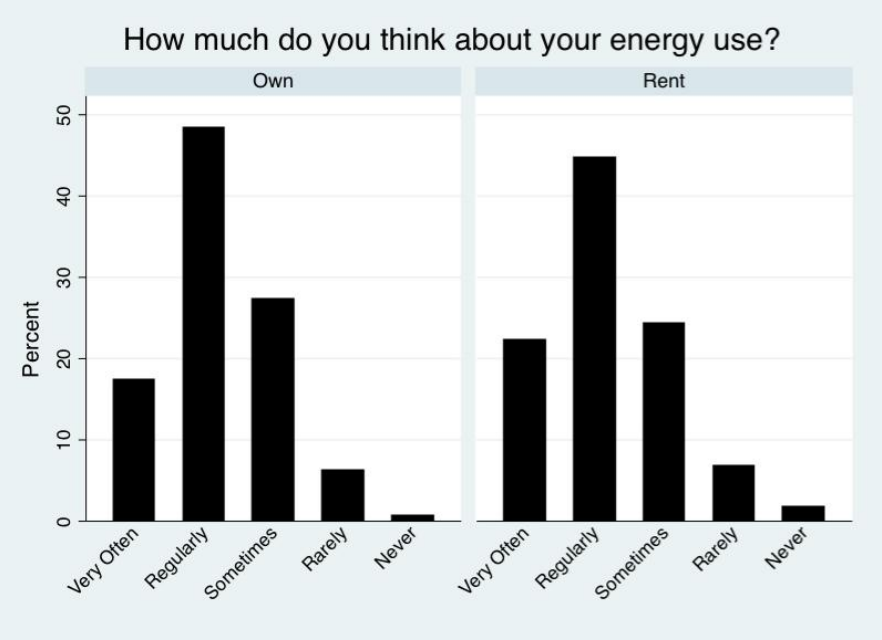
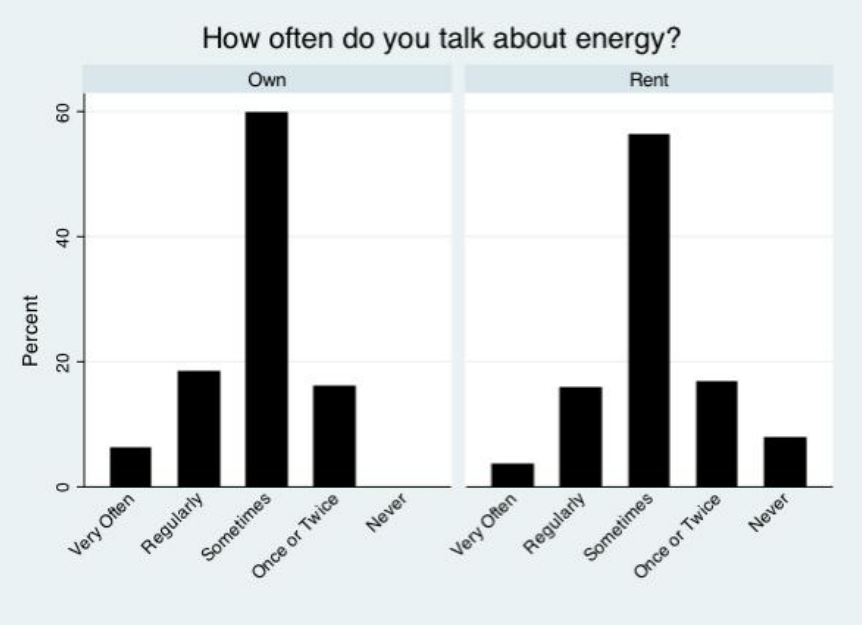


Figure 5.29: Conversations about energy consumption (frequencies were not further clarified)



Some have eagerly learned from others:

> It's always nice to learn a new, easy trick whether we adopt it or not. I found out from a friend that the thing that a microwave delegates the most energy to is it's display. We didn't end up adopting the tactic of only plugging it in to use the microwave.

> The advice on heating and cooling the home received from family and friends has been useful. They've also lent me floor fans which helps circulate the air.

Many conversations revolve around air conditioning and alternatives. It is clear from the descriptions of these conversations that the low users generally appreciate that while they have figured out ways to live with less energy, others aren't always in a position to implement their recommendations or seem to have different priorities:

> I understand comfort is quite personal, so I don't push my agenda beyond my own home. But I do talk about my own habits, and my reasons behind them, and how easy it is to implement them (and that comfort can be had at 80 degrees).
>
> I "promote" installation of whole house fan and how wonderful it works; cools off home much faster than A/C
>
> People always want to know about the small way I live -- sometimes enthusiastically; sometimes with animosity. I explain it all away by saying that my needs are few; needing to live that way; enjoying the mild irony and the benefits all around.
>
> Mostly I tell people that I don't use the air conditioner much, just wear fewer clothes and drink water. It makes me more acclimatized to the heat.
>
> Generally, I'm responding to others' complaints about the high cost of utilities, so I share my strategies. Unfortunately, it seems like families and other factors constrain other folks' ability to save energy in the same ways I do.

Others' curiosity about low usage:

> People always want to know what I do to minimize my utility bill and I explain (as previously discussed in earlier answer).
>
> Just that mine is so much lower than anyone else I know. Mostly they think it is strange that I don't care for air conditioning and don't have it.

A mutually stimulating exchange of energy tips:

> I have extremely low energy consumption and as a result utility costs. I tell anyone who wants to know how I do it. If I receive a suggestion that will help me conserve more I take it under consideration.
>
> Sometimes family members have expressed concerns that I may not use air conditioning when it might be called for, although I doubt this generally. One friend suggested putting up some kind of sun drapes or the like outside my kitchen window. I was concerned about how they would be controlled, and whether this would be acceptable to the management of the building. Generally I do have a policy of keeping windows and blinds closed if a window is expressed to direct sunlight, as well as generally in summer. One exception is early in the morning, when the sun has risen but there is a cooling breeze so that the net effect of opening this and other windows to permit cross-ventilation will be to cool the space. This I term "natural central air conditioning."
>
> My brother and I are both interested in saving energy and lowering utility costs, so we often exchange ideas that have worked for us. I work in the environmental field, so my coworkers are also generally interested in energy conservation, and we exchange tips and ideas. I use my coworkers and my brother for ideas about things to try to save energy, and I pass on ideas I've garnered to them. These interactions are all very positive--we're all working toward the same goal, yet we recognize that because of different circumstances, we can't always choose the very

> most energy efficient thing (for instance, I'd love a battery electric vehicle, but there's nowhere to charge it at my apartment complex).
>
> gave family members a checklist of ways to reduse energy cost. started a group or green gaurdian at work to help monitor energy use and help cut down on waste

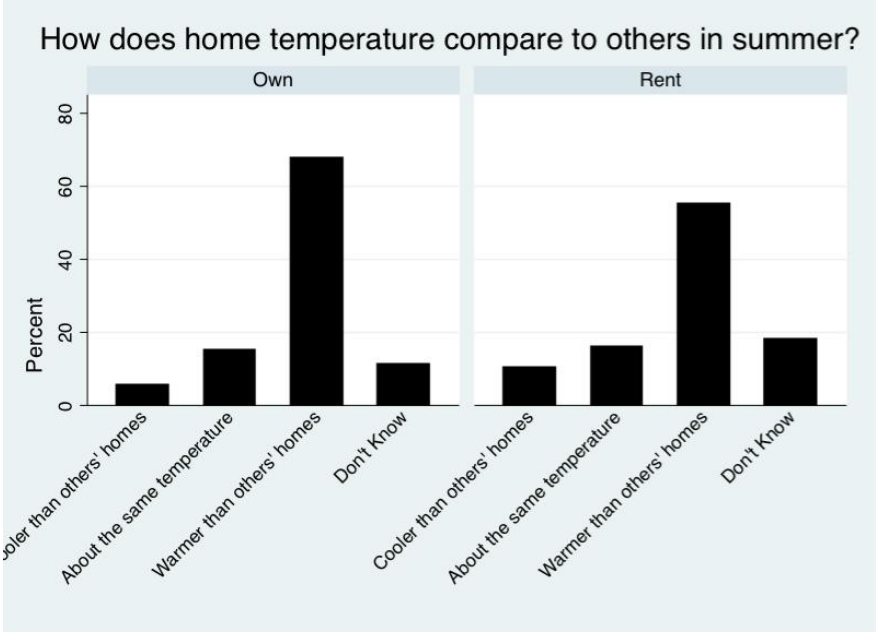
Ignorance of energy basics is another theme:

> Most of the people in my apartment complex seem not to modify their habits according to the weather or season. They leave their windows closed and run the ac or heater almost all the time. I guess they don't know any better. Or maybe they don't mind paying high electricity bills.

Some lament the struggles to make energy efficiency technologies work satisfactorily:

> Have mostly compared notes and asked about improvements each other has made. Have talked about the dislike of CFL's in terms of light quality, risk and challenge of fit for different fixtures and programable light switches. Have also talked about the frustration of the delay in getting hot water to start with the tankless water heater which is even more of an issue after a low flow head was added to the kitchen faucet.
>
> We are always talking about how cold it is in the office, and how different people like different temperature settings--eg 78 degrees vs 68 degrees. We also talk about the Delta breeze and how wonderful it is at night--makes Sac summers tolerable!

Figure 5.30: Difference in perceived indoor summer temperature between survey respondents' homes and the general population



More homeowners (65%) than renters (55%) think their homes are warmer in the summer than others.' Besides using the answer to this question as one of the criteria in developing the profile of those low users we term *Thermally Unflappable* (see Chapter 6), the prevalence of this answer also speaks to the fact that with or without A/C, summers in Sacramento can get pretty hot. A recurring theme in many of the interviews as well as in some of the survey answers was the habit of their neighbors to leave their A/C on 'all the time.' This was quite obviously not

likely to be a practice for the low use households, and on that basis alone it is easy to conjecture that others' houses would be cooler in the summer.

Energy Usage and Quality of Life

We asked a two-part question in the survey about respondents' sense of their quality of life, and, separately, about their view of the relationship between energy usage and quality of life.

The follow up question was:

> If you consumed more energy in your home, do you think your quality of life would be _better _worse _about the same _don't know.

A majority of respondents said *about the same*. Less than 10% said better.

We then asked them to elaborate on their answer. The percentages listed below and in Figures 5.33 and 5.34 are calculated relative to the total number of those who answered the open ended question (51 homeowners, 231 renters). Eleven percent of renters and 6% of homeowners felt there was a positive relationship between increased energy usage and their quality of life.

They specifically identified increased (thermal) comfort as the anticipated result of the hypothetical increase in energy use. A larger share (13% of renters, 14% of homeowners) expressed the opposite view, that increased energy usage would either correspond to a reduced quality of life, or that reducing energy usage would improve their quality of life. The largest share of these answers (36% renter, 40% homeowner) answered that they saw no relationship between energy usage and quality of life, and/or felt that things were fine the way they are.

Figure 5.31: Self-reported quality of life in the bottom decile of electricity consumers (multiple choice question)

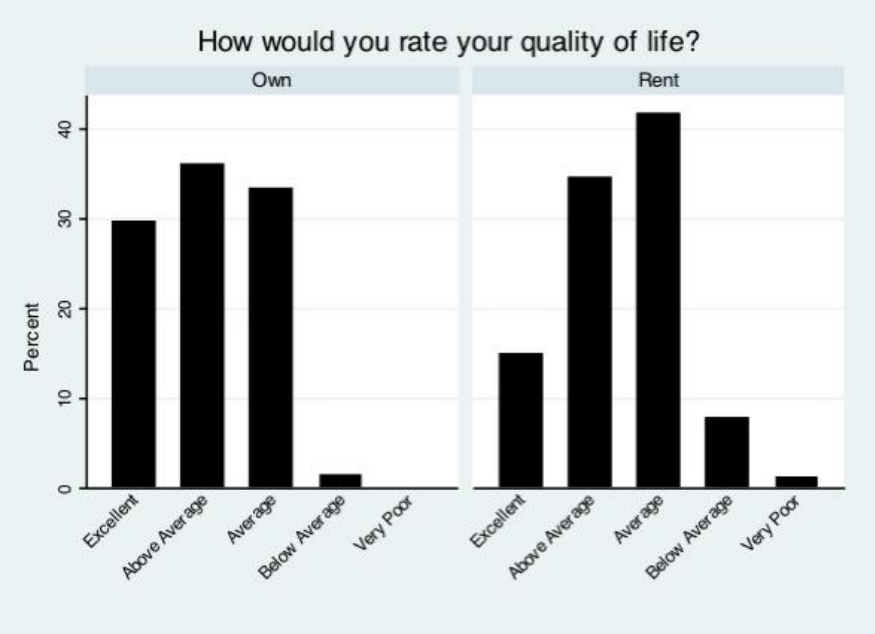


Figure 5.32: Self-reported quality of life in relation to increased energy use in the bottom decile of electricity consumers

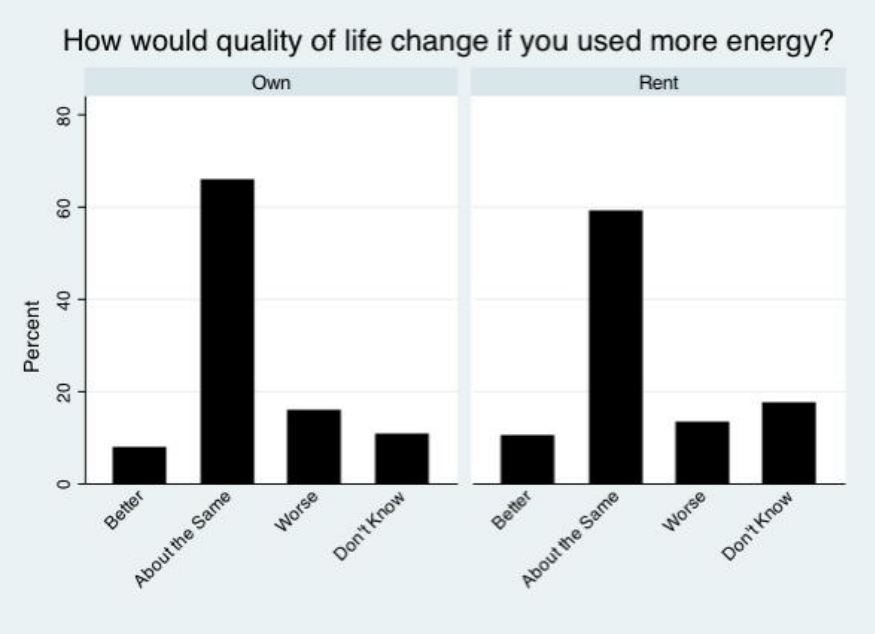
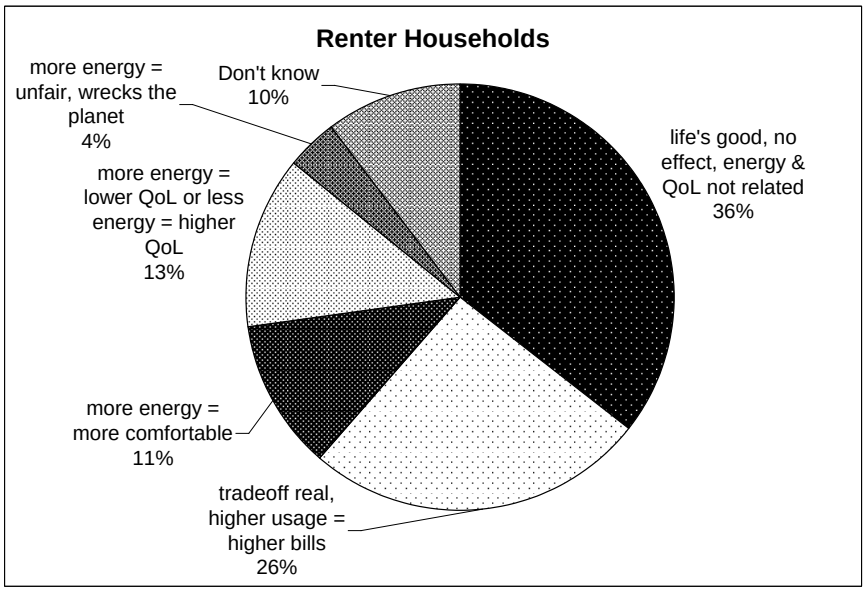


Figure 5.33: How increased energy use impacts quality of life for renters (open-ended question)

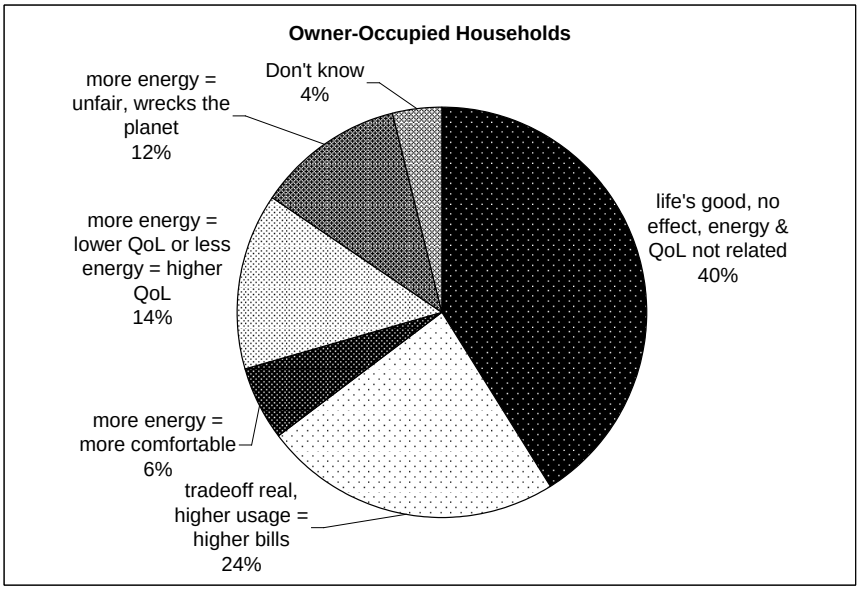


In addition, 12% of homeowners and 4% of renters felt there were social or environmental reasons why increased energy usage would specifically be detrimental, and in their view would impinge on their quality of life as they understood it. *Equity, guilt, waste, fairness, over-consumption, helping the planet, simple living, earthly share, feeling bad* were phrases used by these respondents to describe the consequences of increased energy use. Finally, 26% of renters and 24% of homeowners felt that increased energy use represented a tradeoff, that the higher usage implied would translate to higher bills, and that those higher bills would explicitly not correspond to a better quality of life for them. This was the one category of responses where

financial constraints reduced their choices about energy; and their present low use circumstances could be attributable—at least in part—to a lack of money to pay for more energy services.

Adding together those who see a tradeoff and those who feel there is a positive relationship between increased energy use and comfort we find that 37% of renters and 30% of homeowners who responded to the open-ended part of the question view extra energy as yielding a tangible benefit, *excluding the disbenefit of paying for the extra energy*. Forty-three percent (282/658) of those who answered the multiple choice question answered the open ended portion of the question, and nearly all of those (85% renters, 92% homeowners) who said it would negatively affect their quality of life responded to the opened ended portion. They appear to have interpreted the question slightly differently than we intended. In their interpretation, more energy corresponds to a worse quality of life, not because the extra energy would be a negative or unnecessary but because the extra expense of paying for that extra energy would be a negative.

Figure 5.34: How increased energy use impacts quality of life for homeowners (open-ended question)



A majority (53% of renters; 66% of homeowners) of these lowest decile respondents who explained their reasoning did not hue to that interpretation, preferring instead to think of a hypothetical energy consumption increase as either irrelevant or detrimental to their quality of life, or specifically damaging to the planet.

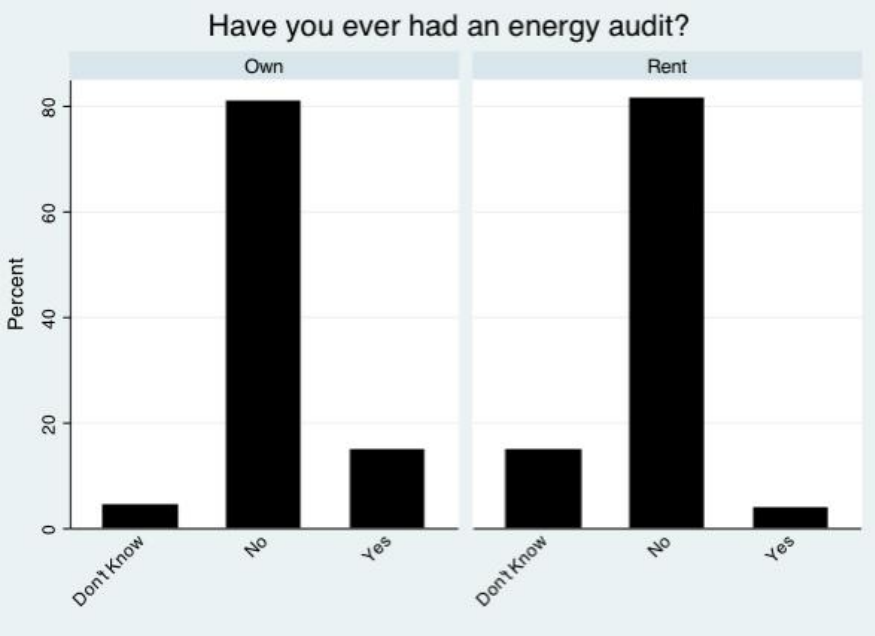
Energy Efficiency Incentives and Energy Audits

Hypotheses #4, mentioned above, addresses the degree to which low users achieved their low usage by following expert advice, or by other routes. Expert advice and the incentives and programs that surround it are designed to help residential customers improve the energy efficiency of their houses, their appliances, or to persuade them to make other changes that improve energy performance. As such it seemed reasonable to examine the extent to which those households whose usage is lowest have taken advantage of these programs.

We asked four questions related to audits and incentives in our survey. We asked whether these low use customers had had a home energy audit or received any incentives to improve

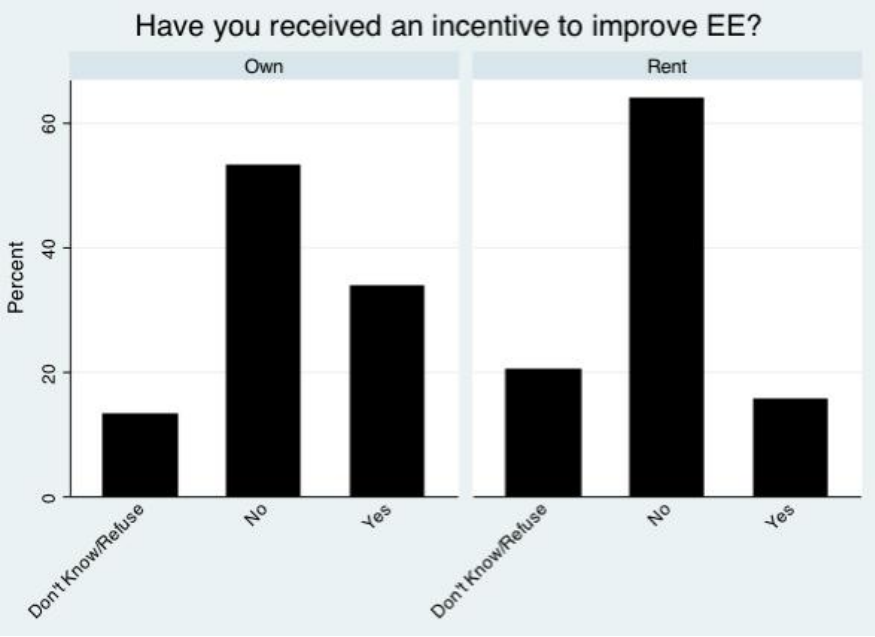
energy efficiency of their home, and if so to please describe those incentives. Finally we asked them if they thought the incentives had reduced their electricity bill.

Figure 5.35: Participation in utility energy audit



Very few reported having a home energy audit.

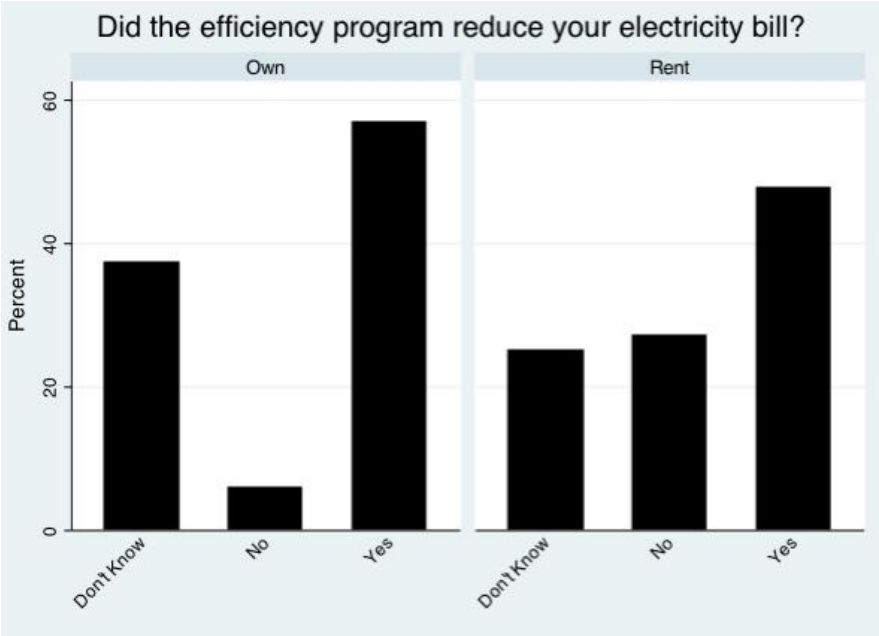
Figure 5:36 Participation in utility incentive programs



We asked the respondents who had received incentives (35% of homeowners; 17% of renters) to list them. Among the homeowners, the incentives they mentioned fell into three broad categories: thermal appliances (window or central AC, furnace, fan, thermostat), general

appliances, including water heaters and refrigerator rebates, and envelope upgrades (windows, insulation, air sealing). Seventeen percent of renter households who received incentives identified a different set. The largest category of incentives the renters reported receiving was in the form of a reduction in their monthly bill resulting from having used less energy (sometimes electricity, sometimes gas) than in the prior year. Demand response, peak pricing, and time of use were another popular category. In addition to windows and insulation, shade trees and solar shades were mentioned by renters. A few general appliances and heating and cooling related replacement rebates rounded out the list. A small number of renters who responded to this question did not distinguish energy assistance (low income, senior, etc.) from the framing of incentives we had intended—to mean a monetary and/or physical exchange designed to facilitate or encourage a reduction in electricity usage. We believe that this confusion influenced the relatively higher 'no' response by renters to the question that Figure 5.37 addresses below. Slightly more than 50% of homeowners and slightly less than 50% of renters who participated in an efficiency program felt that it had reduced their electricity bill:.

Figure 5.37: Electricity bill impacts from energy efficiency program



Low users approach energy conservation from many different perspectives. We have noted the specific strategies and routines, or in some cases the lack of either, and we have tried to organize the responses in such a manner that the low use population would start to take shape. The types of low users we differentiated in Table 5.2

- **Behaviors and Energy Efficient**,
- **Behaviors and Non-Use,**
- **Just How It Is,** and
- **Constraints**

represent our attempt to utilize the data we have, and that was necessarily exploratory since we knew nothing about the energy behaviors or other qualitative dimensions of low use at the outset.

While we have not yet established relative shares of the four types of low user, the discussion of profiles in Chapter 6 will help to approximate how the population aligns with these categories.

6 LOW USAGE PROFILES

Very little research has focused on people who use very little energy, and what makes their low usage possible. One of the objectives of this project was to identify profiles within the sample that might enrich our understanding of who these very low users are, highlighting some of the ways they are similar or different from the intended audiences. The idea of generating several profiles through which to examine low usage was also expected to yield insights about policy recommendations.

All of the households examined in this research use less electricity than 90 percent of the utility customers. So at that first level, any of them should potentially have something to teach the rest of the population about using considerably less electricity. But as already discussed, critics of this research project have made some assumptions about the households that constitute this very low user population. This folk theory could be considered its own profile, and so we've included it in the list below. According to this view, the list of characteristics assumed to adhere to very low users includes a low income, small living quarters, and a lack of choice about energy matters. Those in that tier are imagined to be there involuntarily; therefore it is assumed little of policy relevance can be learned from studying them.[8] While the critics' profile appears in our sample, numerically it is but one of several and certainly not the dominant one. We refer to this profile as *Unhappily Low Energy*.

We have identified five additional profiles that capture other characteristics of this population. To generate them we filtered the sample according to their answers to different questions and demographic criteria. We did not include motivations as a component of these profiles because our survey and interview questions focused on establishing who the low users are, and how they accomplish low usage, not why. The ability to ask what motivated them to use little electricity required us to know more about them than we did at the outset. These categories are intended to familiarize the imagined audiences of the results from this research with the low use population. These profiles concretize low usage by presenting different slices through this population with the expectation that audiences would recognize something in the presentation, and possibly find it evocative. Policies designed to translate what we are learning about low usage can treat these profiles as points of departure.

Relying on statistics from the utility dataset, the Residential Appliance Saturation Survey (RASS), as well as our survey and interview responses, we were able to identify and describe the following categories within the low use population. The criteria we used to generate these profiles appear in the list below.

1. Well Off and Energy Efficient (51 out of 277[9] = 18.5%)

- Quality of Life - Above Average or Excellent
- Education - At least a 2-year college degree
- Income - Greater than $50,000
- Home Size - Larger than 1,000 ft2

[8] This is debatable, but certainly the other profiles yield more readily accessible insights and more closely align with demographic groups typically envisioned as audiences of energy policy.

[9] One note about the size of each profile: the larger number in the parentheses refers to the total number of low users who responded to all the questions on which this profile is based. Missing data on one or more of the list of criteria eliminates that respondent from the pool.

- Own all of the following electric appliances: refrigerator, washing machine, dryer, electric water heater, central A/C, dishwasher, microwave, TV, DVD, computer
- Have done something to improve their energy efficiency

2. Excellent Quality of Life (158 out of 658 = 24.0%)
- Quality of Life - Excellent

3. Thermally Unflappable (53 out of 340 = 15.6%)
- A/C - have either Central or Window
- Use A/C either Once/Twice a year or Never
- Temperature warmer than others' homes in the summer
- Quality of Life - Average or Better

4. Ultra-low Users (208 out of 687 = 30.3%)
- Average usage 52 - 208 kWh/month

5. Sacramento Average (103 out of 469 = 22.0%)
- Income - between $30,000 and $100,000
- Home Size - between 500 and 1,500 ft2
- Education - at least a high school degree and at most a 4-year college degree
- Quality of Life - Average or Above Average
- Age - between 25 and 64 years old

6. Unhappily Low Energy (23 out of 476 = 4.8%)
- Income - Less than $50,000
- Home Size - Less than 1,000 ft2
- Quality of Life – Below Average or Very Poor
- Age > 35

Taking the population for each profile to be the number of survey respondents who don't have any missing values for the variables used in creating the restrictions, we get the following shares. 438 out of 695 survey respondents (63%) fall into at least one profile

Table 6.1: Distribution of respondents across the profile categories

Number of profiles respondent belongs to	Number of survey respondents	Percent of total survey respondents
0	257	37%
1	302	43.5%
2	116	16.7%
3	18	2.6%
4	2	0.3%
Total	695	100.0%

Table 6.2: Cross tabulations of profiles for respondents fitting two or more profiles

	Well off and efficient	Unhappily low energy	Thermally Unflappable	Sac Average	Ultra-low	Excellent QoL
Well off and efficient	51					
Unhappily low energy	0	23				
Thermally unflappable	5	0	53			
Sac Average	2	0	7	103		
Ultra-low	12	3	31	29	208	
Excellent Quality of Life	25	0	18	0	50	158

Figure 6.1: Distribution of monthly electricity consumption across the six profiles compared

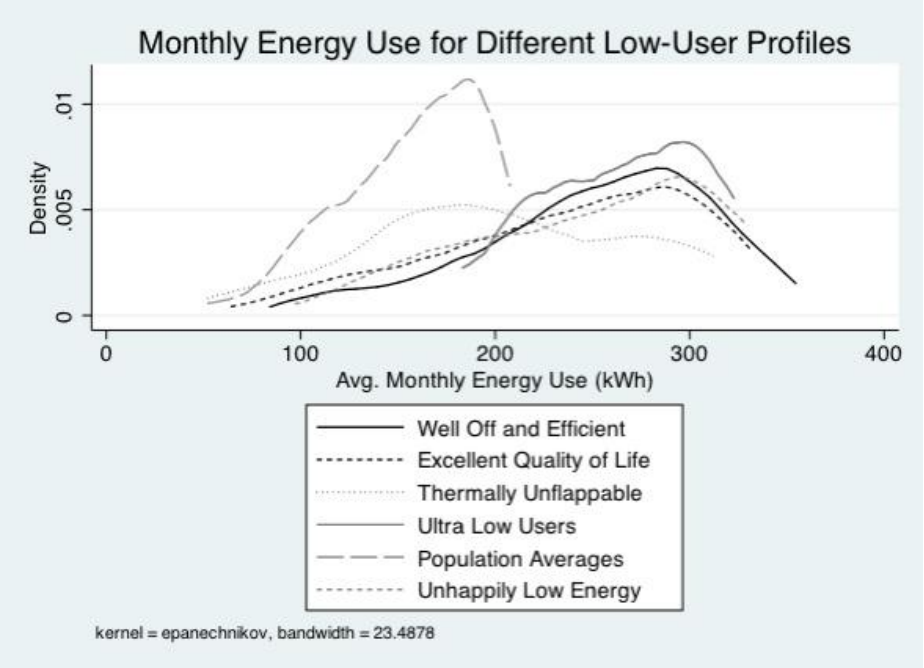


Figure 6.1 compares the electricity consumption of the six profiles, showing the range as well as a measure of central tendency. The two profiles that stand out from the rest are the Ultra Low Users, which are concentrated around 180 kWh/month and the Thermally Unflappable with a similar if much less pronounced peak. The others cluster around 300 kWh/month, but have long tails toward the lower bound of the population, a distribution not unlike what we observe for the lowest decile as a whole (Figure 5.2). Figures 6.2 - 6.4 will be referenced in the case study discussions below.

Figure 6.2: Average monthly electricity consumption across the six profiles compared.

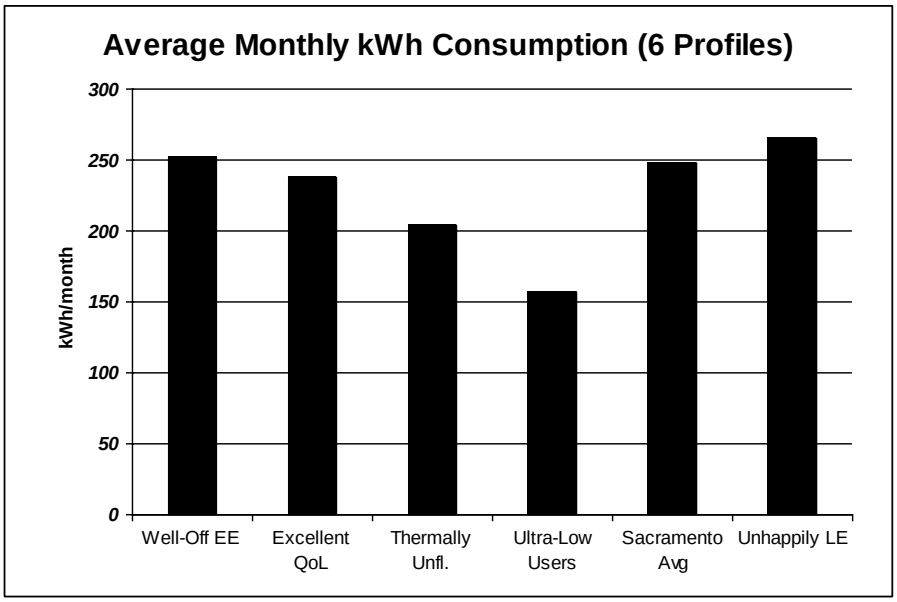


Figure 6.3: Average household size across the six profiles compared.

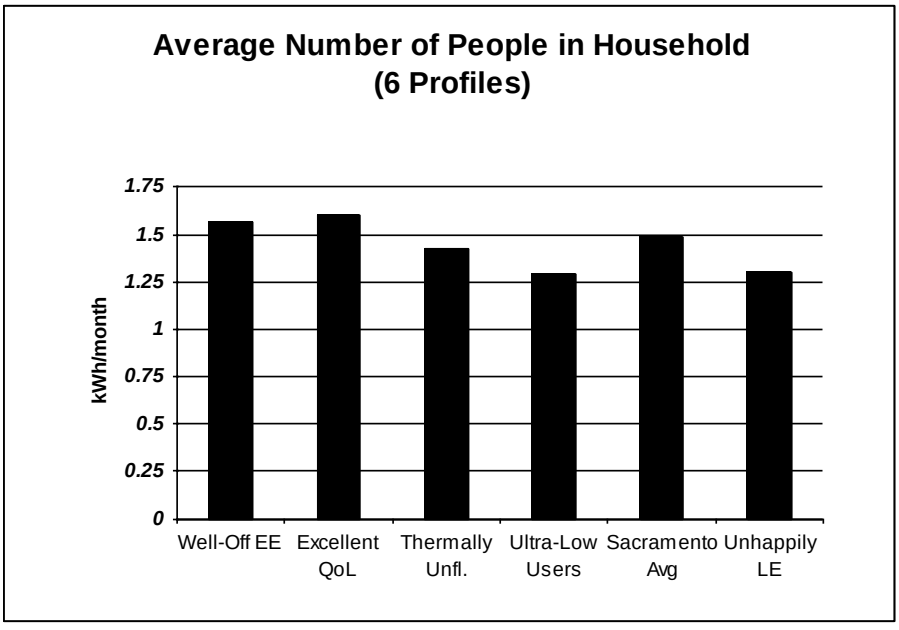
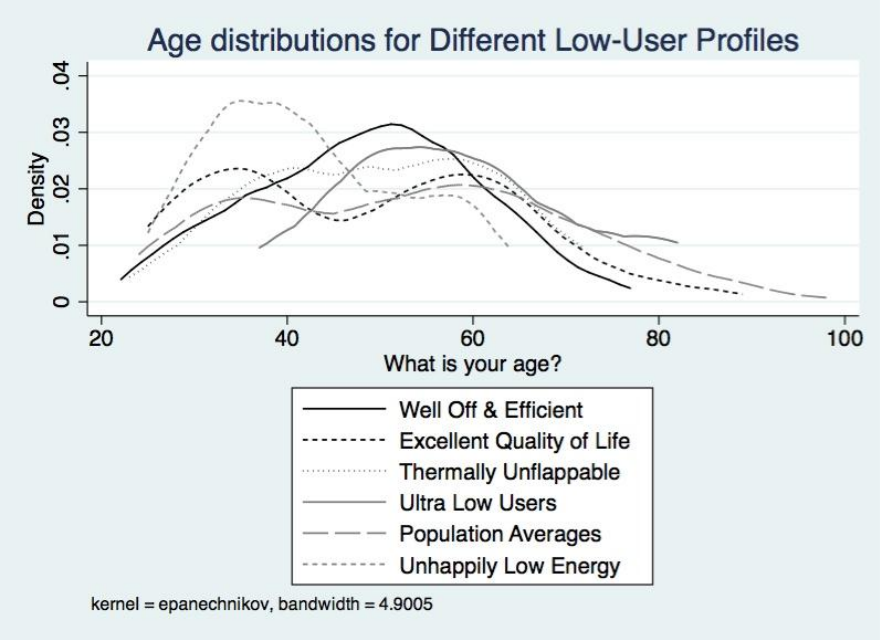


Figure 6.4: Age distributions of the six profiles compared



Case Studies of Six Profiles

1. Well Off and Energy Efficient

This profile was conceived as the opposite of the Unhappily Low Energy designation, with a high income, large house, the full suite of electrical appliances, and self-identified above average or excellent quality of life. To round out the profile we also stipulated that those in this group must have participated in or engaged in some effort to improve the energy efficiency of their dwelling. Approximately 19% of the sample from which the profile was generated fit these criteria.

As Figure 6.2 illustrates, this profile includes households whose electricity consumption is as low as 100 kWh/month, a level that is well below the 2050 target anticipated in Executive Order S-03-05.

Five of the interviews we conducted were with people who are in this profile. We've included answers from four of them below. The first set of answers below is from a single woman who fit into both this profile as well as the Ultra-Low Users. Her average monthly kWh consumption for the three year period 2008-2010 was 208 kWh. We asked her to identify two or three of the most important ways she keeps cool in the summer:

> Have all the blinds drawn. Keep the house dark. Or, I may have the windows open. The last resort would be the air conditioner. I grew up in San Francisco, so air conditioning to me is just not the first thing I grab for. So, keep the house as dark as I can, and then also I do open the windows to let a breeze in if I can. And then the air conditioning systems would be the third thing. I try not to use appliances until late in the evening and everything. Even the dryer warms up the house, and so I try not to use that at all.
>
> As a Bay Area kid, we had fog. I mean, air conditioning in a car was a luxury. So, when I moved here, I learned very quickly that we do really have summers here. You can be as stoic as you can be, but there's a point in time that you're just being stupid, and when the dog looks like it's about to pass out. So, I have

> now learned that it is okay to turn on the air conditioner, as long as I use it judiciously. I don't leave it running at night, because it dries me out. So, I still use it sparingly, I don't leave it on during the day. I try not to use energy, because I know we have, you know, energy watching and everything like that. I try to be as conservative with use as I possibly can. Use it when I absolutely have to. I'm not going to put it on when it's 85 degrees outside. When it starts hitting 99, 100 then I start using it. I'm a little bit more liberal with putting it on and everything. (388)

We also asked the people we interviewed if they had recommendations for others in similar circumstances who use more energy. This is her answer:

> But, see if you can try to be comfortable and not try to cool the house down to an iceberg. I know it's probably more comfortable that way, but try to see if you can stay within what's recommended. And, like in fall, you know, do the same things. Don't use your appliances; maybe try to eat light meals that don't require cooking. Try to make the house dark during the day when you're not there. There's only one person in this house, but just try to be considerate, because there's other people who might need the energy. I work in a hospital, so I think of people who need the energy so we don't have a problem, that have like, oxygen at home. That sticks in my head, that they need energy a lot more than I do. And just, you know, try to be as conservative as you possibly can. Don't make yourself uncomfortable. That's not the point of it. But just think in the back of your mind, do you really need to be doing that right now? Or do you really need to have it at 75? Try to find a cool part of the room. Luckily my den is a nice, cool spot, so I just go in there and hang out there most of the time when I come home, because it's nice and cool in there. And that's what I can think of. (388)

Another interviewee in this profile lives with his wife and two children. In the course of remodeling they had replaced the A/C, put in double pane windows, and insulated. Their average electricity consumption was 266 kWh/month. His/their strategies for staying cool are below:

> I keep everything shut during the day. Blinds drawn, all of that. And then open up at night. The other thing is, we had it insulated a few years ago. Additional insulation in the attic, and the other thing is trees surrounding the house.
> Interviewer: Do you rely on a thermostat to control the temperature in your home in the summer?
> P10: No, I wouldn't say rely on it, we use it, but…
> Interviewer: Okay. And what temperatures do you set that at?
> P10: In the summer, 78 to 80.
> Interviewer: Okay. And do you adjust that sometimes? How often do you interact with the thermostat?
> P10: Infrequently. The days that we turn it on, I'd say we might…just turn it on, and then that's it. And then just turn it off at night. That's the average.
> Interviewer: Above what temperature do you consider it to be uncomfortably hot in the summer indoors?
> P10: 82. Yeah, for me, I'm speaking family, because I'm not the only one. I can go up to 85. That's okay, but 82 is pretty much what the wife will stand. So it's 82.
> Interviewer: And under what circumstances does that happen?
> P10: You know, coming home later during a hot spell, that kind of thing. (269)

This third person lives alone and has the same monthly electricity bill as the family above.

> Interviewer: Since you moved into the house you live in now, have you changed the way you cool, adopted new strategies, or modified any other methods of keeping cool?
> P11: That's kind of difficult. You know, I lived in a place that had no air conditioning before I moved in here, or only had a little window unit. So, I've learned to use the whole house fan more often, like in the morning when it's cool out. And I've done a lot of energy improvements since I've lived here to keep it more moderate. You know, like, more insulation, and dual pane windows, and things like that. (190)

We asked about upgrades to appliances and the house vs. behaviors and habits:

Well, yeah. I feel like both are really important, and so I really strive to do both. Frequently, any time I can upgrade something, or I need to replace something, I'm looking for something more energy efficient. For example, my dishwasher is about ready to die, and I'm carefully researching what is the most water efficient and energy efficient, relatively affordable model that I can get, and I'm probably going to go with something much more expensive than I had originally intended. So I'm always looking for the more energy efficient things, but I'm also pretty conscious in my daily patterns, and will put up with more heat than most people. Or in the winter, I'll let it be a little bit cooler than I really like, and just dress warmer, just for the purpose of saving energy. (190)

A couple who live downtown without central A/C explain how they keep things cool:

Okay. Well, when we're at home, one of the things that we did is when we bought the house thirteen years ago. There were a couple of window units on the second floor- this is an old house. It's over a hundred and ten years old. It's Norfolk Victorian, and it was designed in a particular way…you know, there's more overhangs, do that depending on what direction the sun is, it will keep the sun out of the windows. But, one of the things that we've done is we put in, like, fake wood blinds with like, three inch slats, and we turn them in a way so that it blocks the sun from coming in. And as soon as we put those up in place of the vinyl blinds that were in there when we bought the house, it lowered the temperature on the second floor probably five degrees. It was amazing.

The other thing was we put in a whole house fan. We took out the window units because they're ridiculous, you know? Old, and not very efficient. But, we put in a whole house fan that could draw from the whole house. In Sacramento we have, except for maybe a couple of weeks in the year, we have a very good, strong delta breeze that comes in from Altamont Pass at the end of the day, and it just kind of, it cools the place down at maybe, nine or ten at night. That's the weather pattern. We'll have thirty or forty degree temperature swing. A lot of people here I think maybe don't take advantage of it. They just keep their house shut up and try to cool it rather than let cool air in. Once we figured out, I mean we're not from here, but once we figured out that that was the pattern, we realized that we could get by. Especially since we're downtown and there are very big trees around us that help as well, you know, we didn't plant them five years ago, but there they are, so…So anyway, putting in a whole house fan definitely was the best thousand dollars we ever spent, because it does cool down the house pretty quickly. Sometimes we have to run it all night to get cold air in by four o'clock in the morning, but generally speaking, I would say there's only two weeks out of the year when it's too hot to sleep on the second floor. It's pretty amazing when you think we're in a place that gets up to a hundred and fifteen.

Well, we have a basement, and the basement stays at about seventy-eight. It's only after it's been really hot for a really long time that it starts to heat up down there. But it stays relatively much cooler down there. So, there have been summers when I just move. I take my laptop and I go downstairs. There have been times, I think in the past, where people who have lived in houses have slept in the basement during the heat. You know, it's just like, what people did before they had air conditioning. (96)

Finally here is how she describes the conversation with her neighbors about reducing their high energy bills:

I know people who…there's only two of us in the house, and, you know, this was right after we moved in. You know, our next-door neighbors who've lived there the same amount of time, you know, moved in at about the same time as we did. And…maybe a year later, we were talking about what our electric bill was. Because they were saying, "Oh my god, it's so high" And, it was like, three hundred something dollars. "How much was yours?" And we said, "Oh…thirty-five?"

Well, they had a Jacuzzi outside, which they have gotten rid of. They never opened their second floor. And they finally figure out that, open your windows on your second floor and vent it out, right? They were coming in from someplace else, too. They were relying on air conditioning, and that's just, you know, sucking up juice. Since then, I think, they definitely rely on central air, and we don't have it. But I think that, since learning about what we were doing, they did alter their behavior. They actually open their windows now. And they got rid of the Jacuzzi! (96)

These people actively sought out energy upgrades for their typically large houses, and combined these with typically detailed strategies and routines for using little electricity. The chief insight about the people in this profile is that the energy efficiency route, when combined with a fair amount of attention to energy related habits and behaviors can lead to usage that is in some cases comfortably below the tenth percentile, even for families.

2. Excellent Quality of Life

This profile is very simply defined as including all households which identified as experiencing an above average or excellent quality of life. No other restrictions obtain; the idea being that for this profile what matters is simply that these low use households are pleased with their circumstances. What characteristics the group as a whole exhibits will be explored below. This profile comprises 24% of the eligible sample.

We interviewed nine households who fit into this profile. We've excerpted from three of them below. Coincidentally these three two-person households are also members of the Ultra-Low User profile discussed below This first interview below was with a woman who lives with her husband. Their average consumption was 192 kWh/month. Their house is between 1000-1499 square feet, built in 1910. They've lived in it for 15 years. Their income is between $100 and $150,000.

The three sets of things she emphasized were (a) developing energy-inspired routines and habits around a large number of tasks,

- use cold water for washing all of our laundry,
- spend more time outside where it is cool because of the shade trees,
- timing showers to coincide to limit indoor humidity,
- sleeping on linen sheets is a lot cooler than sleeping on cotton,
- limiting computer time,
- don't bake in the summertime,
- stopped decorating the house with lights at the holiday times,

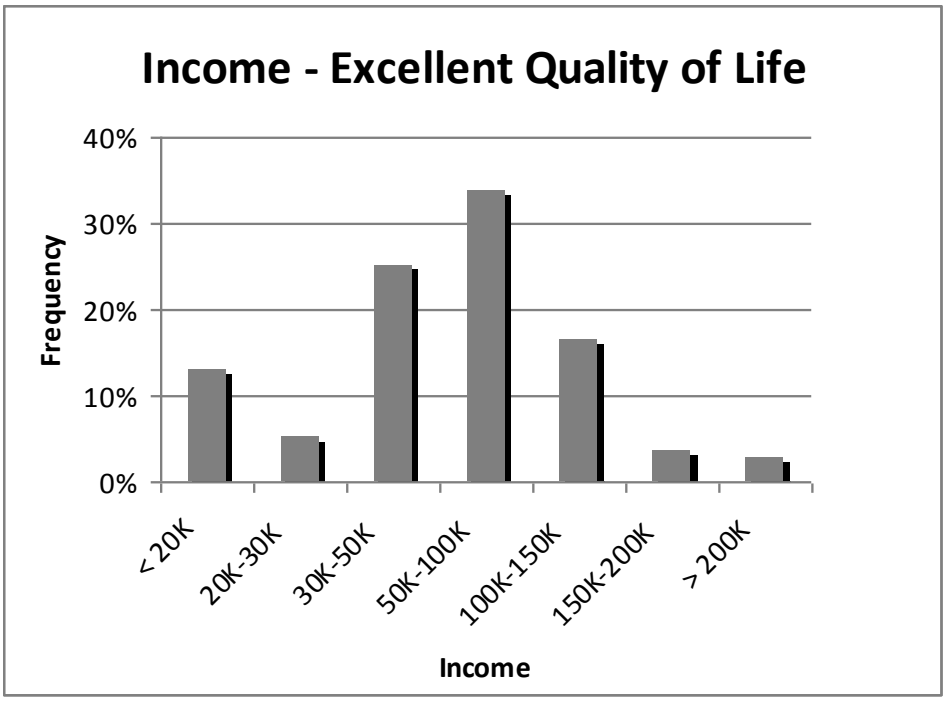
and (b) doing without a bunch of appliances and electrical devices,

- no clothes dryer
- no TV
- no electric clocks
- no big computers that give off heat

and (c) making modifications to the house and its environs:

- shading with "old-fashioned metal shade screens that we put up just in the summertime on the west-facing windows. And that works really well. You see them on old people's houses around."
- replaced all the mini-blinds with cloth curtains,
- put the tiles floors in where there was carpeting, and the tile feels cooler,
- plant shade trees. (364)

Figure 6.5: Income distribution within the Excellent Quality of Life profile



This couple's average monthly consumption is 126kWh. They did a bunch of things to optimize their old two-story house, from realigning the doorways to optimize the breeze to building window insulation panels.

> So, the thermostat on my heating system controls nothing related to cooling. So in the summer, I do nothing. The thermostat is just- it has a temperature reading on it, and I use that just to see what temperature it is in the house. But it controls nothing as far as cooling. Absolutely no mechanical cooling except for ceiling fans. And they're not controlled by thermostat. I installed one window air conditioner for the room I was sleeping in, and the noise was such that I learned to live without it. I took it out and I never put it back in. It's in the attic in a box.
>
> We use these sheets of rigid foam insulation we buy at Home Depot. They are an inch or an inch and a half thick; I think I have both, depending on when I bought the stuff. It comes in four by eight sheets of pretty common insulation material. I cut them to fit inside my windows. So, on a hot summer day, I insert them into the frame of the window, and it blocks the light as well as the heat. Because it has aluminum on both sides, it reflects a lot of the heat back out. So that's one way we keep the heat out in the first place, so that we don't need air conditioning.
> And then, you know, when it starts feeling warm in the evening, that's when I know it's cooler outside, it's time to open up and reverse the situation. So, thermal mass gets charged with heat during the day a little bit, and then it discharges it at night when that wind, the air is blowing through and removes some of the heat. I know I'm unusual; this not the normal way that people live. (152)

A third couple whose usage was similarly low at 206 kWh/month, had very little to say besides mentioning their whole house fan and upgrades to their insulation.

> There's nothing magic, really. This house has nothing magic in it (197)

Their house is between 1500-1999 square feet, built in 1963. They've lived in it for 47 years. Their income is between $30 and $50,000. The last two households above share some traits (ultra-low usage, older, white, two person household, but the specifics diverge. One has a Central A/C they use rarely, the other doesn't have any A/C. Perhaps the largest difference is in how they represent their level of engagement with the issue even as they arrive at essentially the same, untypical result. Some go to great lengths while others see their accomplishments in a different light or may not even be aware that they are unusual.

The Excellent Quality of Life profile includes plenty of thoughtful people willing to talk about their energy consumption and how the go about their lives, but overall it is a fairly heterogeneous group. Figure 6.5 shows the income distribution of this group. This figure along with several others discussed above casts doubt on any simple equation of energy consumption with quality of life.

3. Thermally Unflappable

We created this profile because cooling practices emerged as such a crucial dimension of the experiences discussed by the low users we surveyed. The members of this group have air conditioning but rarely if ever use it. They assume that the summer temperatures in their homes are probably higher than is typical, but they do not view the low- or non-use of AC as a limitation. Members of this group consider their quality of life to be average or better. Approximately 16% of the eligible sample is included in this profile.

We have already said a lot about air conditioning and alternatives to it in this report. The idea behind generating a profile around this behavior is intended to highlight the choice to do without an air conditioner in a climate with a high saturation of this end use technology. The saturation figures are commonly assumed to correspond to usage. Non-users of a piece of hardware as expensive and culturally visible as a central A/C is not something we know much about, outside of emergencies, when as we've seen some people are quite willing to exceed official recommendations and turn the A/C off (Lutzenhiser 2002). What motivates or permits this group to get by without A/C. Under what circumstances do they use it if at all? What are their reasons for this non-use? Figure 6.6 suggests it is probably not cost for those in the higher income brackets.

We conducted two interviews with members of this profile. Below are excerpts from both of them.

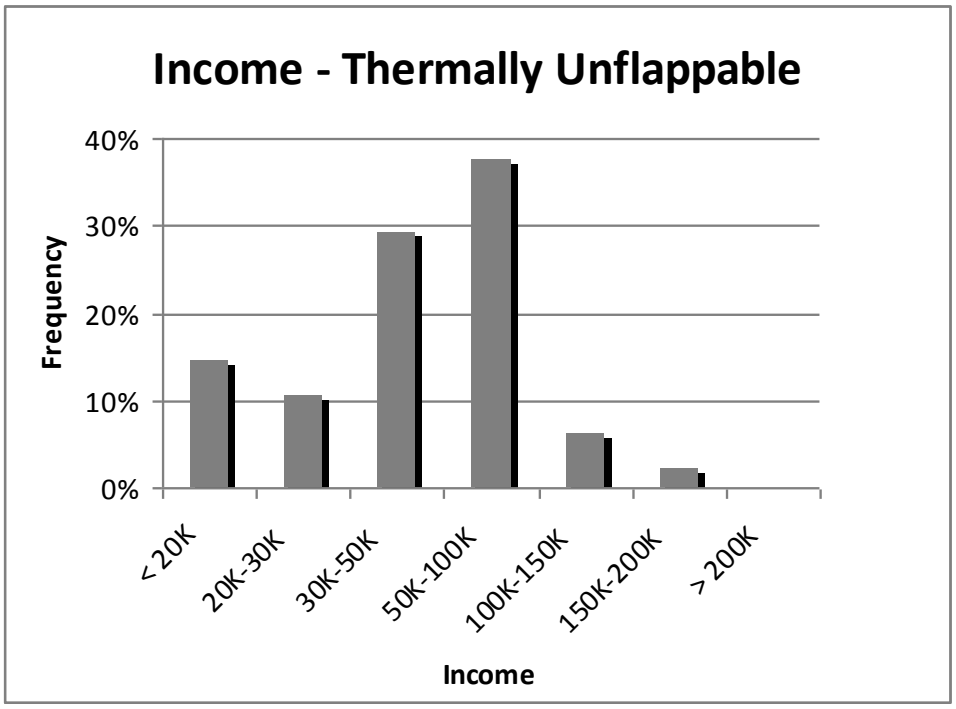
> P14: Well, our house is equipped with plantation shutters, and also we have tile. Throughout the house we have hardwood floors. And our house has…six fans. And then what we do is, we close the shutters, so we don't allow the sun to come into the room. That way, we block the sun. So that's how we keep cool.
> Interviewer: Do you rely on a thermostat to control the temperature in your home during the summer?
> P14: Not really, because we don't usually use the air conditioning, because our house is open.
> Interviewer: Do you attribute your low usage to any particular baits and behaviors?
> P14: No, we just…it's like if we are cold, we just wear a sweater. We're not in the habit of putting on the air conditioning, you know. Or if it's hot, or if it's cold, put the heater on. We just wear two sweaters, and then we are comfortable in the house like that. (257)
> I use my whole house fan when it cools down outside. Oh, and another…I take cold showers. Not complete showers, I just get my hair wet. (348)

> P23: I have friends who will not give up their comfort. They need to be absolutely comfortable all the time. I think that's the biggest factor. They will turn on the AC when it's warm, and they'll turn on the heat when

it's cold. Right now, it's cold, but I don't have the heater on. I don't know; it's just behavior. And the whole house fan is magical. It's the best invention ever.
Interviewer: That's great. When you say that you have friends that won't give up their comfort, would you characterize yourself as uncomfortable? Or is it maybe part of the attitude about defining comfort, and what people are tolerant of?
P23: Defining comfort. I was born and raised in San Francisco. And over there, it never gets this hot or this cold ever. And I guess because it's much cooler…the coolness is consistent. So I guess as far as the summertime, or the winter, I'm more tolerant. And in the summertime, it's just…because I was raised…my father was the only breadwinner in the house. There were six of us. And my father was very careful with how we left doors open, turned on the lights, left them on, and stuff like that. So all of that was ingrained in me, so I'm pretty unique in that sense, where I am careful. (348)

Many people, not just members of this profile, remarked about the air conditioning habits of their neighbors, especially how hard it was for them to understand their neighbors' tendency to leave it running all day when they are not home.

Figure 6.6: Income distribution within the Thermally Unflappable profile



4. Ultra-low Users

Ultra-low users are the members of the sample whose usage falls below the third percentile of the general population, or between 52 and 208 kWh/mo. No other eligibility criteria obtain. Just under one-third of the survey sample is included in this profile. This group is of symbolic significance as their consumption levels of electricity most closely approximate the 2050 target identified in Executive Order S-03-05. These are households that most any lower bound cutoff would have eliminated from the study. If we think of the lowest decile as including best practices within that band of consumption—and this research project is organized to identify some of them—then this profile, by virtue of having a much lower upper bound, intensifies that goal. In

this lowest tier we again find diversity across demographic categories, suggesting that, at least in principle, usage below the third percentile is not limited to any particular group.

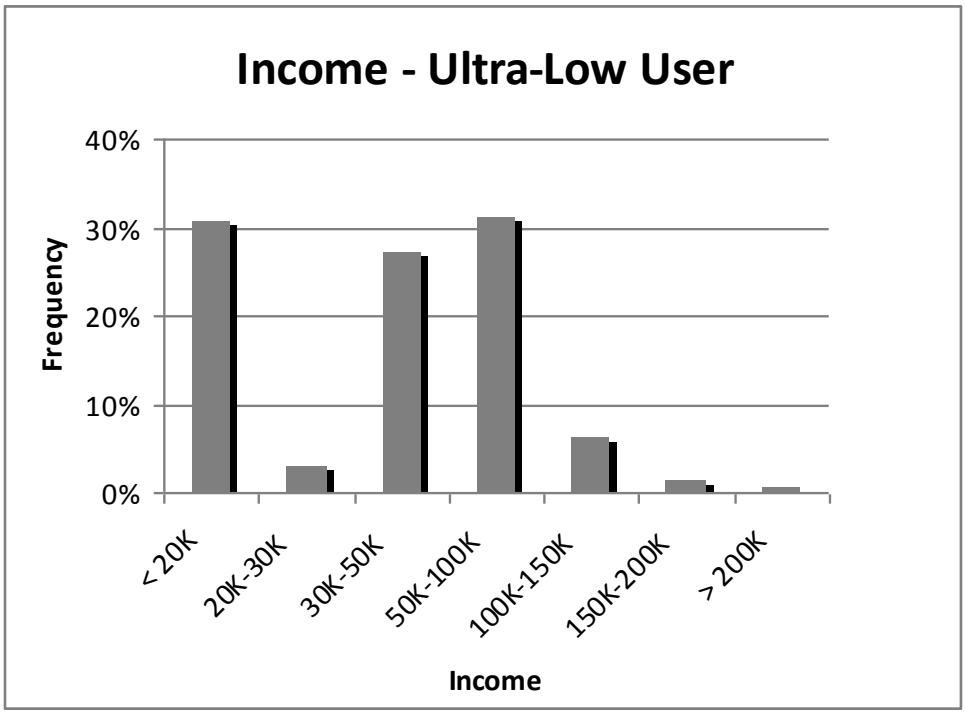
The fact that the Well-off and Efficient category overlaps with this profile is instructive. As we have seen in the interview excerpts from people who are in that category (above), their usage is in some cases well within this range. Outward markers of social or financial success appear to be compatible with electricity usage at a level lower than 97% of the population. To the extent that policymakers or the public assume a fundamental tradeoff between choice, comfort, and convenience and very low electricity consumption, this overlap should help to counterbalance that notion. The fact that one-third of the households identified as Sacramento Average also fit the ultra-low user profile underscores the extent to which very low energy consumption is not a good predictor of income, or vice versa.

Below are three charts that examine income distribution within this large subcategory of the low user population. The first (Figure 6.8) is like the previous charts. The income distribution is here much more bi-modal, with roughly 1/3 of the population in one of three non-adjacent income brackets. But perhaps the most striking feature of this population is the household size. As Figure 6.3 indicates, the average is noticeably smaller than for all but one of the others at 1.25 people. This works out to 80% single occupant households and 17% with 2 people. This suggests that it is difficult though certainly not impossible to be in this tier with more than one person. We managed to interview nine households in this profile, including three of the two-person households who we met above through the Excellent Quality of Life profile (152, 197, and 364).

> P08: I got a brand new system! I want to say…about three years ago. I got a new heater and a new air conditioner. I had to upgrade it plus the damn thing was so noisy! So I have upgraded that. I have it checked out yearly by the company. He laughed at me when I showed him what I did. I tried to protect it during the winter, so that it doesn't get water and leaves in it. I actually put a cover on it when it's not in use during the fall. And then…I haven't had it done yet, but I have them look at the air ducts when they come out. That's a project for the future to be done.
> Interviewer: So, once you got the new air conditioner, did you find that your habits around that changed? Or were they pretty much the same?
> P08: Pretty much the same. I have to say I probably put it on a little bit more. Because it's a little but more energy efficient, I didn't feel as guilty, so maybe I used it a little bit more than when I used the old one, because the old one like I said was noisy, and I just felt guilty wasting energy. (388)

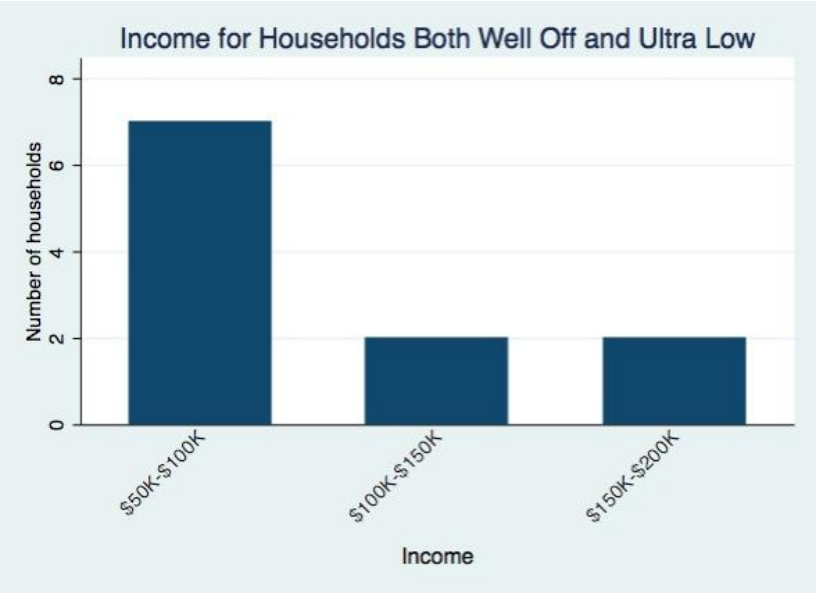
> P05: Well, I live upstairs. So I can keep my windows open. And right here where I live, it's how the sun hits the windows where I live, too. And the shade, I'm in the back of a building, where I get afternoon shade. So I can keep my windows open for most of the time. But when it gets too, too uncomfortable, I can close them up and turn on my air conditioner, which I try not to do because I prefer the fresh air. And I'm safe, because I'm upstairs. So, I know people who live downstairs that can't live that way at all. That seems to be a major difference.
> Interviewer: Interesting. In my experience the heat rises, and so it's often cooler downstairs than upstairs, but I'm hearing a very different stratification in your case.
> P05: Circulating the air is key to keeping it cool and fresh. And the best way is through the windows, and I think the cheapest. Yeah, and I just feel so claustrophobic without my windows open. So it's a lot of things. And I'm just cautious about not using my air conditioner more than I need to. I don't have animals, so I don't have to cool my house when I'm not home. You know what I mean?
> Interviewer: Oh yes, absolutely. People do that, and it's surprising to some of us.
> P05: Yeah, because I'm thrifty. I've learned that I've had to do that to survive in the world. And it makes me feel good when I feel like I'm being careful and conscientious, and responsible. Does that answer that question? (213)

Figure 6.7: Income distribution within the Ultra-Low User profile



The incomes of the households in the overlap of these two profile-pairs appear in the figures below.

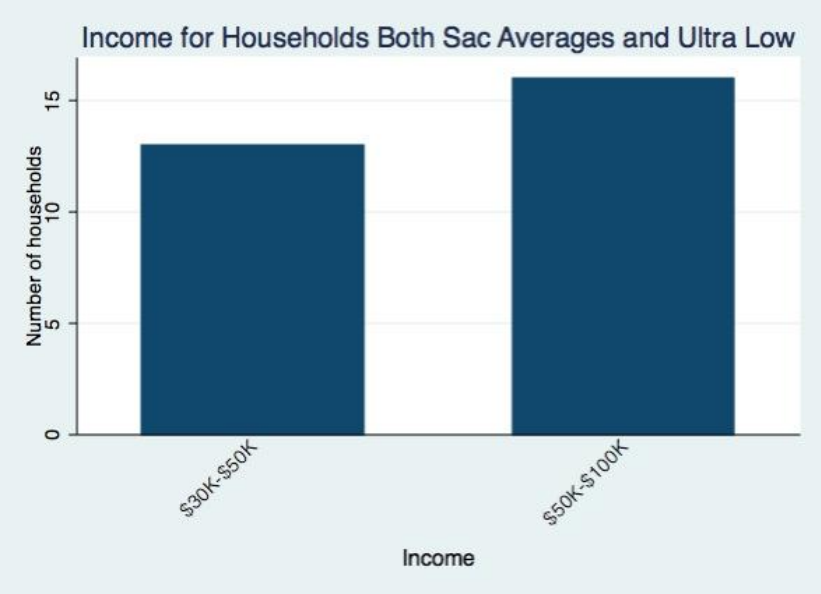
Figure 6.8: Income distribution of the households that appear in both profiles 1 and 4



Ultra-low users are a heterogeneous group. Like the lowest decile, energy use tiers by themselves end up including lots of otherwise dissimilar people. Whether the diverse pathways by which people end up in this profile end up interpreted by others whose usage is not as low but

who may share some characteristics as an invitation to explore this territory remains to be seen. But to the extent that the 2050 target can be interpreted to allow for this usage level, the diversity within this profile seems promising.

Figure 6.9: Income distribution of the households that appear in both profiles 4 and 5



5. Sacramento Average

Twenty-two percent of the eligible sample are included in this profile, which is meant to reflect mid-range values across a number of different demographic categories: income, home size, education, and age. Quality of life is considered by members of this group to be either average or above average.

In answers to the open ended survey questions about what they have done to lower their energy consumption respondents who belong to this profile mentioned a broad cross section of things, from infrequent use of the dishwasher, washing machine, and dryer, to preferring to open and close windows and use fans to cut down on the amount of time the A/C is running. Higher A/C thermostat settings 78F, 80F were also mentioned frequently as were the use of CFLs and turning things off.

On the relationship between increased energy use and quality of life, Sacramento Average respondents made the following observations:

> I don't prefer to spend my money on utilities. I try to keep my overhead low so that I can enjoy other things (travel, food, experiences) that do improve my quality of life.
>
> I would be worrying about wasting electricity. - Using up something that I didn't really need.
>
> It would be depleted natural resources which would cause me to feel I wasn't doing my part to help the environment. I would be paying out more in bills which would give me less money to spend on other things and not help the economy.
>
> I like to conserve whether I can afford alot or not. On the other hand, I do think it is nicer to have comfort. It is either one way or another because I can have comfort even with less unless the temp gets too extreme.

I don't mind saving energy so it wouldn't matter if I have a little discomfort once in a while

6. Unhappily Low Energy

As mentioned above, this profile is designed to capture the folk theory about this tier of the population as using little energy not by choice. They are unable to consume as much energy as they would prefer because of circumstances beyond their control. Low income and small home size are considered the chief criteria and we have relied on these to generate this profile. Quality of life is judged below average or very poor. The age restriction above 35 years is included to cull students from this category, but its effect on the size of the profile population turned out to be very slight. This profile represents about 5% of the eligible sample.

Although some low users fit the stereotype, this study has shown that the tier of low users—even the tier of ultra-low users—encompasses a diverse cross section of the population, and that this profile is not an accurate characterization of low use *per se*. Some individuals and households would use more energy if they could, and it is important not to lose sight of that fact. But for the present purposes it is important to recognize that low electricity usage, as examined in this study, and being too poor to afford more energy services are two different issues that overlap to some extent. The fact that some poor people use much less energy than the average (as observed in this study), while others use more than the average,[10] points to the fact that poverty and energy usage are related in ways that are more complex than a simple assertion that very low energy users are probably poor acknowledges. We have attempted to demonstrate that the relationship between income and electricity use, as well as income and more direct measures of happiness or quality of life is not fixed. One illustration of this is that the mean kWh consumption level of this Unhappily Low Energy profile is actually slightly higher than the others (see Figures 6.1 and 6.2). Although the resolution of our dataset does not permit us to calculate this for the present population, others have observed that, "low-income dwellings generally use more energy per unit area; [which] is largely a reflection of the low quality of poor people's housing." (McAllister 1991)

We have tried to estimate the share of the lowest decile made up of those whose energy use is low not by choice but by circumstance. It is important to understand this question because in the absence of any prior investigation of low user demographics, speculation about who would be found there converged on this group. We have therefore tried to estimate the size of this group, it's share of the low use population using three different methods.

(1) Adding up what we refer to as constraints mentioned by respondents in the course of explaining their (low) energy use.

(2) By carefully reviewing the answers to the open-ended question about the relationship between more energy use and quality of life, and

(3) Generating this sixth profile of those whose income, home size, and quality of life assessment would seem to correspond to the caricature of low users as unhappy or poor.

[10] Various bill paying assistance programs both at the local, state, and federal level, are designed to help poor people pay their heating bills and as such these are premised to some degree on the existence of high energy usage among poor people.

(1) Identifying constraints is not a filter for unhappiness *per se*, but a tally of circumstances that (a) a subset of low users identify as (partially) explaining their low usage, and (b) are recognizable markers of modest conditions, or conditions at odds with our notion of middle class domestic life. While living alone in a small apartment and not being home very much are neither necessary nor sufficient criteria for low usage, finding that some low users fit that description is also not surprising. About one quarter (23% of owners and 24.5% of renters) of the low users who responded to the relevant questions (91% of our sample) mentioned at least one constraint in relation to their energy usage (live alone, not home much, on a budget, or small apartment).

(2) Examining subtleties within the responses to our open-ended question about energy consumption and quality of life revealed a slightly larger—if also self-selected—share of the low users who identified positive attributes to consuming more energy. This group consists of those who identified increased (thermal) comfort as the anticipated result of the hypothetical increase in energy use (6% of homeowners and 11% of renters) and those who felt that increased energy use represented a tradeoff; that the higher usage implied would translate to higher bills, and that those higher bills would detract from their quality of life (24% of homeowners and 26% of renters). This was the one category of responses where financial constraints were seen as reducing their choices about energy; and we consequently interpret their present low use circumstances—at least in part—to a lack of money to pay for more energy services. If we ignore the self selection in the response rates to the last question, combining those figures we find 30% of homeowners and 37% of renters in this category.

(3) The third method, finally, which we used to generate the profile under discussion, relies on a set of filters tied to income, home size, and respondent's age, in addition to an unfavorable answer to the question about their present quality of life. This yielded a combined rate of 5%, but since this filter did not include any homeowners, the share of the renter population who fit the parameters of this profile is 6%.

These three attempts to gauge the share of the low user population that uses little energy at least in part because of circumstances evidence some constraints are the best we can do with the available data. The wide range of values and the difficulty interpreting the responses to the questions about quality of life and energy suggest some of the uncertainty around these estimates. But in light of our various attempts to quantify subsets of this population we think it unlikely that more than 30% of homeowners and 37% of renters can be considered to be in this category.

These profiles do not constitute an exhaustive typology of the low use population. While these six represent facets of what we've observed within this population, and several of them incorporate energy behaviors, an attempt to classify the types of low user according to their approach to energy conservation

7 SUMMARY AND CONCLUSIONS

This research started from the premise that low usage, and the patterns of living that make it possible, is for all practical purposes invisible, and that rendering it visible could open up new possibilities for encouraging the public to take more responsibility for reducing their energy consumption. One way to do this involves reframing the issue of home energy consumption as one of possibility rather than effort or burden. To make low usage visible, this project examined the usage patterns among residential customers in the lowest decile of the population served by a Northern California electric utility.

This study was designed around four main research questions:

1. Is very low electricity usage real? Are households whose electricity consumption registers below the tenth percentile even occupied?
2. Who lives in the very low usage tier? How is the population similar or different from the general population?
3. What circumstances, patterns of behavior, strategies, and attitudes are associated with low usage?
4. What insights can be derived from a study of low usage that could inform policies designed to encourage reductions in electricity consumption by others?

To help answer the first question we created a set of filters to exclude what we suspected might be unoccupied households beyond the filters the utility had created to generate the low user dataset on our behalf. The sample which resulted included only accounts with sufficient variability (year-to-year and peak-to-off-peak) that we felt comfortable treating them as occupied. Our survey response rate confirmed that there were occupied households in this range, and that even the very lowest tiers were populated with a diverse range of people willing to answer our survey questions and talk to us about their usage over the telephone. Therefore not only is low electricity usage real, we found no evidence that even the very lowest levels of our sample were unoccupied. Although for practical purposes we identified a lower bound in our study, there is no reason to think there aren't occupied households below that cutoff.

We explored the second question, "Who lives in the very low usage tier? How is the population similar or different from the general population" using a variety of techniques. This research project was not chiefly concerned with examining the averages for the lowest decile but with understanding the range and diversity of this population. Is it homogeneous? Are there demographic or other criteria that distinguish the lowest decile from the general population, that suggest *a priori* reasons why low usage might be difficult to replicate?

Although on average floor area, number of people, and income were found to be slightly lower for the lowest decile population, this view obscures the more interesting result which is that the lowest decile includes every demographic segment found in the general population: wealthy and poor, large houses and small apartments, members of all races, ages, and education levels. The variation in income in the bottom decile appears to be similar (or maybe larger) than in the general population. Other demographic categories exhibit similar characteristics.

The third question, "What circumstances, patterns of behavior, strategies, and attitudes are associated with low usage?" adds a qualitative dimension to the second question. Answers to a number of the open-ended survey questions as well as the telephone interviews revealed a good

deal about how these people achieve their low usage, why they are engaged to a greater or lesser degree in the pursuit of a low energy lifestyle, and what differentiates them among each other.

We derived six profiles from among the low user population to understand in detail what characteristics they may share with others whose usage is not currently low, or what could make low users familiar to potential audiences. The six profiles include **Well Off and Energy Efficient** (18.5%), **Excellent Quality of Life** (24%), **Thermally Unflappable** (15.6%), **Ultra-low Users** (30.3%), **Sacramento Average** (22%), and **Unhappily Low Energy** (4.8%). Several profiles speak to the variation in how members accomplish their low usage. Well-Off and Energy Efficient refers to those in the upper income, education, and home size tiers who indicated pursuit of energy efficiency improvements. Thermally Unflappable refers to those enjoy an average or better quality of life and who rarely or never use their A/C. Ultra-low Users are the users whose consumption approximates California's 2050 target. The last profile attempts to capture the folk theory about who would be found in the low use population using criteria such as house size, income and a statement about quality of life.

Table 7.1: Types of Low Users

Types of Low Users	Description	Actions
Behaviors + EE	Actively engaged on energy, self-motivated (varying combinations of behavior and efficient technologies)	Thermal mgmt routines, upgrades
Behaviors + Non-Use	Actively engaged on energy, modest lifestyle, prefer to have and use less stuff	Turn off/don't have/ don't use
Just How It Is	No special efforts and little self-awareness about energy	x
Constraints	Wouldn't mind consuming more energy if they could	Don't have/ not home

Building on the insights from the typology of substitutions (see Table 5.1), a matrix that organizes energy behaviors according to eight principles, including doing without, running only full loads, matching the scale of the device to the task, and upgrading to a more energy efficiency version, we identified four approaches to low usage (Table 7.1), the first two of which are the most policy-relevant: **Behaviors and Energy Efficient**, **Behaviors and Non-Use**, **Just How It Is**, and **Constraints**. Additional research is needed to estimate the relative sizes of these categories, but our results suggest at least half of the lowest decile falls into the two first groups, whose engagement with the subject of energy is high. The first category **Behaviors and Energy Efficient** includes people who follow expert advice on energy efficiency, augmenting the investment in technologies or building improvements with more or less elaborate routines and behaviors. The second, **Behaviors and Non-Use** go about it in a slightly different way. Because they are content not to have so many appliances or other electrical devices, or to use them less frequently, they manage to use little without investing in upgrades. The third category **Just How It Is** use little energy without recognizing it as exceptional. Consequently they have little to say about their efforts. The fourth category **Constraints** includes people whose usage is low not because they aspire to it but because one or more constraints, including not being home much, living alone or in a small apartment, or the inability to afford to spend more on energy, keeps their usage low. While it is tempting to discount low electricity usage by people living alone as more easily achieved, the majority of single person households in this utility territory are not in

fact in the lowest decile. Any efforts to target renters or small households should take this into account.

The final research question, "What insights can be derived from a study of low usage that could inform policies designed to encourage reductions in electricity consumption by others?" seeks to bring these insights to bear on the matter of policy. How can we translate findings that suggest a multiplicity of pathways to low usage in the present into marketing and outreach campaigns, images, and inspiring stories that could augment or anchor the policy framings of residential energy conservation and energy efficiency?

Energy efficiency can be a key ingredient in very low usage. A majority of low users in our study followed expert advice on energy behaviors, and a significant number invested in upgrades to their house or appliances. Recognizing that these efforts can, in combination, yield usage below the tenth or even the third percentile is important because it suggests far greater reductions are achievable using familiar strategies than is commonly assumed.

The lengths to which many of those in the lowest decile were willing to go to accomplish their low usage, the specific routines and tricks they devised for keeping cool without running the air conditioner, or optimizing other household tasks, from the quirky to the mundane, could animate the topic of energy considerably. The realization that others, including perhaps one's neighbors, care about the issue of energy that much, or have at least managed to reduce their consumption, can strengthen and enliven the conversation about energy. Energy usage is, after all, very much embedded in a social context, shaped by a shared understanding of what is normal, and what is involved in achieving comfort. Introducing these people's stories, their dedication, or even those who manage to use little energy without trying can be used to concretize the goal of reduced consumption.

The lowest decile is made up of a diverse range of people, many of whom are engaged in the pursuit of low energy and are willing to reflect on the particulars of how they have achieved comfort *and* low usage. They are potentially a source of information, guidance and inspiration to others who may not have realized or had a chance to discover the ways in which the lifestyles we've grown accustomed to could be enriched by the pursuit of much lower energy consumption.

8 RECOMMENDATIONS

Energy Outreach

We now know who the lowest electricity users are and we know that their experiences and insights could be useful to a much broader audience. We also recognize that inviting input from the public, much less from outliers, is an unfamiliar approach within the policy realm. In thinking about how to pursue very significant reductions in energy consumption, we think all options should be considered, and incorporating what we have learned about the lowest users into policy and outreach efforts holds considerable promise.

One of the objectives of this research has been to dispel the notion that those who use very little energy are fundamentally unlike the rest of the population and therefore presumably do not conduct themselves in ways the imagined audiences would recognize or appreciate. Because the social, demographic, and possibly motivational, distances between the low users we've studied and the imagined publics is revealed to be much smaller than imagined, a key challenge is to communicate these insights effectively. Some people (individuals or groups) may be open to the possibility of taking on more responsibility for their energy consumption, but without a story, a coherent set of terms known to have yielded lower usage, they may not have considered it. We have not taken advantage of the experience and insights of these individuals because we hadn't thought to ask them.

This section of the report outlines a series of recommendations for how state policy makers and utility program designers could incorporate some of the key insights from this research. The ultimate audience is of course the public, but at this level we are concerned with making the results from this research useful to those who already engage with various publics on this general topic. Our findings build on and complement existing utility outreach efforts, which, as we have seen, are very successful, at least among the population we studied.

Recommendations for State Policy Makers

- **Incorporate low usage into policy framings**. Find ways to recognize and incorporate the independent pursuit of low usage by a segment of the population into the conversation about how to achieve climate change objectives.
- **Leverage the discovery of low usage** into a broad-based reevaluation of the limits to how we have approached home energy conservation and efficiency.
- **Low usage is possible**. Introduce the fact of very low usage to the public. Include the diversity of people, circumstances, and pathways by which they achieve this low usage.
- **Expand the conversation.** Including the outliers legitimizes their efforts and enriches the conversation. By discussing the topic in a new light we can all learn. Our energy usage is shaped in part by what we consider normal, what we think our peers are willing to do when it comes to arbitrating between, for instance, comfort and energy, so expanding what is considered feasible can only advance the effort to reduce energy consumption.

Recommendations for Utilities

- **Learn from low users**. Augment the existing lists of recommendations with strategies observed among the lowest users. Enroll their expertise.
- **Tell stories.** Embedding lowest usage recommendations in the stories and specifics contributed by the lowest users has the potential to increase the salience of the subject.

- **Use actual consumption figures in outreach.** Anchoring the recommendations to the specifics of a (very) low bill has the potential to advance the conversation, moving beyond the (relative) framing of energy efficiency to the (absolute) framing of California climate change targets.
- **Celebrate lowest users.** Organize contests. Invite input from lowest users. Recognize their accomplishments.
- **Consider using social media.** Invite input from lowest users as well as those who are not. Organize a conversation where peers can share their experiences. Thinking of decisions about energy use strictly in terms of the individual or household is a mistake. Some of the changes discussed in this report could result from peer support and accountability.
- **Adopt the approach pioneered by Gainesville, FL.** They placed all customer utility information on the web in a searchable platform "to enable us all to make better decisions about our energy usage."

Suggestions for Future Research

Explore the possibility of developing a low usage curriculum or guidebook
Identify what the relative shares of the Low User classifications are.

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APPENDIX

Survey Instrument

UC DAVIS
HOUSEHOLD ENERGY SURVEY

Instructions

YOUR PARTICIPATION IS VERY IMPORTANT.

The purpose of this survey is to collect information. Your identity and answers will be held in the strictest confidence.

Do your best to answer all of the questions. If you do not know the answer to a question, please provide your best estimate and move on to the next one.
When you have finished, please return the survey in the attached envelope to the address below:

236N
Energy Efficiency Center
University of California Davis
One Shields Avenue
Davis, CA 95616

Thank you for participating!

Alan Meier
UC Davis Principal Investigator

Your Home and Appliances

1. **Do you own or rent your home?** _____

2. **How long have you lived at this address?** _____ Years

3. **What is the approximate square footage (of livable space) in your home?** _____ Sq ft

   - ☐ Less than 500 square feet
   - ☐ 500 - 999 square feet
   - ☐ 1000 - 1499 square feet
   - ☐ 1500 - 1999 square feet
   - ☐ 2000 - 2499 square feet
   - ☐ 2500 - 2999 square feet
   - ☐ More than 3000 square feet
   - ☐ Don't know

4. **In what year was your home built?** _____ Approx Year

5. **Is this your full time residence?**

   - ☐ Yes
   - ☐ No
   - ☐ Other (Please specify):

6. **How many people live here currently?** _____ Full-time

   _____ Part-time

   _____ Occasionally

Your Home and Appliances (Cont.)

7. Please indicate how many of the following *electric* devices you have and use in your home:

Appliance	Number	Regularly Used	Rarely Used
Refrigerator in the house	_____	☐	☐
Refrigerator in the garage or basement	_____	☐	☐
Freezer, separate	_____	☐	☐
Microwave Oven	_____	☐	☐
Dishwasher	_____	☐	☐
Central Air Conditioning Unit	_____	☐	☐
Window Air Conditioning Unit	_____	☐	☐
Whole House/Attic Fan	_____	☐	☐
Swamp Cooler	_____	☐	☐
Television	_____	☐	☐
Cable Box	_____	☐	☐
DVD/Blu-Ray/VCR	_____	☐	☐
Computer	_____	☐	☐
Printer/Fax Machine	_____	☐	☐
Wireless Router	_____	☐	☐
Video Game Console	_____	☐	☐
Stereo	_____	☐	☐
Washing Machine	_____	☐	☐
Clothes Dryer	_____	☐	☐
Water Heater (electric)	_____	☐	☐
Stove/Range	_____	☐	☐
Separate Oven	_____	☐	☐
Furnace/Space Heater	_____	☐	☐
Hot Tub	_____	☐	☐
Swimming Pool	_____	☐	☐
Programmable thermostat	_____	☐	☐
In-Home Energy Display	_____	☐	☐

Other major appliances (describe below):

Your Home and Appliances (Cont.)

8. What type of water heater do you have?

- ☐ Tank (standard)
- ☐ Tankless/On-Demand
- ☐ Electric Heat Pump
- ☐ Solar
- ☐ Other (please specify)
- ☐ Don't Know

9. Do you have any of the following appliances?

- ☐ Gas furnace or heater
- ☐ Gas range and/or oven
- ☐ Gas clothes dryer
- ☐ Gas water heater

10. Are the exterior walls of your house/apartment insulated?

- ☐ Yes
- ☐ No
- ☐ Don’t Know

11. Do you have double-pane windows?

- ☐ Yes
- ☐ No
- ☐ Don’t Know

12. Would you consider your home to be drafty?

- ☐ Yes
- ☐ No
- ☐ Don’t Know

Your Behaviors

13. How much do you think about your electricity use?

- ☐ Very Often
- ☐ Regularly
- ☐ Sometimes
- ☐ Rarely
- ☐ Never

14. Do you think your energy use is --

- ☐ Higher than your neighbors
- ☐ About the same
- ☐ Lower than your neighbors
- ☐ Don't know/Never thought about it

15. What are the reasons your energy use might be higher, lower, or about the same as your neighbors?

16. Have you or other household members done anything to lower your energy consumption at home?

- ☐ Yes
- ☐ No

17. If you have done anything to lower your energy consumption at home (Yes to Question 16), please explain the actions or changes.

18. If you have air conditioning, how often do you use it?

- ☐ Very Often
- ☐ Regularly
- ☐ Sometimes
- ☐ Once or twice a year
- ☐ Never
- ☐ Other (Please specify):

19. In the summertime, compared to other people you know, do you think you generally keep your home…

- ☐ About the same temperature as others' homes

- ☐ Warmer than others' homes
- ☐ Cooler than others' homes
- ☐ Don't Know

20. Do you pay for your electricity usage separately, or is it included in the rent?

- ☐ Pay own
- ☐ Included in rent
- ☐ Other (Please specify): _____
- ☐ Don't Know

21. Do you receive a monthly natural gas bill?

- ☐ Yes
- ☐ No
- ☐ Don't Know

22. How much is your monthly natural gas bill typically? (your best estimate is fine)

- $_____ in the summer
- $_____ in the winter
- ☐ Don't Know
- ☐ Refuse

23. Have you ever had an energy audit of your home?

- ☐ Yes
- ☐ No
- ☐ Don't Know

24. Do you talk about energy usage with anyone?

- ☐ Yes
- ☐ No

IF YOU ANSWERED **NO** PLEASE SKIP TO QUESTION 28

25. If you talk to others about your energy usage, with whom do you speak? You can include more than one answer.

- ☐ Family member
- ☐ Neighbor
- ☐ Energy utility representative
- ☐ Other (Please specify):

26. How frequently do you speak with others about your energy usage?

- ☐ Very Often

- ☐ Regularly
- ☐ Sometimes
- ☐ Once or twice
- ☐ Never

27. Please provide any details about those conversations or advice you may have received and how you felt about it.

28. Have you received any incentives to improve the energy efficiency of your home?

- ☐ Yes
- ☐ No
- ☐ Don't Know

IF YOU ANSWERED **NO/DON'T KNOW**, PLEASE SKIP TO QUESTION 31

29. If you received incentives, please identify and describe the program/incentive.

30. If you received incentives, did the program or incentive reduce your electricity bill?

- ☐ Yes
- ☐ No
- ☐ Don't Know

31. How would you rate your quality of life?

- ☐ Excellent
- ☐ Above Average
- ☐ Average
- ☐ Below Average
- ☐ Very Poor

32. If you consumed <u>more</u> energy in your home, do you think your quality of life would be--

- ☐ Better
- ☐ Worse
- ☐ About the Same
- ☐ Don't Know

Please Explain:

33. How closely do you review your electricity bill?

- ☐ Not at all
- ☐ Some
- ☐ Closely

34. If you learned that your home electricity usage was much lower than the average, can you think of reasons that might help explain your low usage? Please list as many reasons as possible.

Your Household

35. What is your age? Years

36. What is the highest level of education you have completed?

- ☐ No formal education
- ☐ Grade school
- ☐ Some high school
- ☐ Completed high school/GED
- ☐ Some college or technical training
- ☐ Completed 2-year college degree
- ☐ Completed 4-year college degree
- ☐ Some graduate work
- ☐ A graduate degree
- ☐ Don't Know
- ☐ No formal education
- ☐ Refuse

37. What race or ethnicity do you consider yourself? You can include more than one category.

- ☐ Latino or Hispanic
- ☐ Black or African American
- ☐ American Indian or Alaskan Native
- ☐ Asian
- ☐ Native Hawaiian or Pacific Islander
- ☐ White
- ☐ Or some other race (please specify)
- ☐ Don't Know
- ☐ Refuse

Your Household (Cont.)

38. Please indicate which income category best describes your total household income for 2011, BEFORE TAXES and other deductions.

- ☐ Less than $20,000
- ☐ More than $20,000 up to $30,000
- ☐ More than $30,000 up to $50,000
- ☐ More than $50,000 up to $100,000
- ☐ More than $100,000 up to $150,000
- ☐ More than $150,000 up to $200,000
- ☐ Over $200,000
- ☐ Don't Know
- ☐ Refuse

Thank You!

Thank you for taking the time to respond to this survey! Your responses are greatly appreciated.

Please feel free to use this space for any comments or questions you may have regarding this survey.

Interview Guide

Hello, my name is Reuben Deumling. I am a researcher conducting a study with the California Air Resources Board about household energy consumption. I want to thank you very much for responding to our survey we sent out recently. On that survey you said you would be willing to participate in a short follow up interview – these tend to take about 7-10 minutes. I would like to speak to the person living in this household who is 18 years of age or older and who knows the most about your household's energy use. Would that be you or someone else? ___ O.K.

1 = Yes, Continue
2 = No, Not Available - Schedule Callback
3 = Refusals
4 = Wrong Number OR Missing Phone Number
5 = Disconnect/Business or Government/Blocked Call
6 = Non Contact
7 = Communication Barrier (specify: a) language, b) connection quality, c) other)
8 = No one over 18

This interview is voluntary. All of the information you provide will be kept anonymous and confidential. When the results are analyzed, your name will be removed from the data and will not be associated with your answers in any way. If I come to any question you would prefer not to answer, just let me know and I'll skip over it.
Continue.....1
Schedule callback.....2

In your responses to our previous survey, you addressed two issues that I'd like to explore in a bit more depth with you today over the phone.

The first has to do with staying cool in the summer.

1. What are the two or three most important ways you keep cool in the summer when you're at home? Please describe what you do.

2. Do you rely on a thermostat to control the temperature in your home during the summer?
   If **yes**
   a. what temperature is your thermostat typically set to during the summer?
   b. How often do you typically adjust the set temperature?
   (daily, weekly, monthly, never, other)
   If **no** move to next question

3. Above what temperature do you consider it to be uncomfortably hot in the summer **indoors**? (clarify if temp mentioned is indoor or out)
   a. Please describe under what circumstances that typically happens, if ever?
   b. What do you do on days like that?

4. Since you moved into the house you live in now have you changed the way you use your air conditioner, adopted new strategies, or modified any other methods of keeping cool)? If **yes** - Can you elaborate?

    a. Why do you think your patterns have changed (*or didn't change)*?

5. Who in your household has decision-making power over air conditioner use?
    a. Is there anything else you'd care to say about how air conditioning use (or cooling) habits developed in your household?

Stepping back from dealing with the summer heat, I have one question about factors that may have contributed to your low usage of electricity more generally.

6. One common distinction is to think of physical changes to your **house or appliances** on the one hand, and **habits and behaviors** on the other. Do you feel that one of these contributed more to your low usage? I can give examples of each if you'd like.
   - *(improving insulation, shading, or weather-stripping, or purchasing more energy-efficient appliances)*,
   - *(opening and closing windows to moderate the temperature, keeping your thermostat set at a higher temperature in the summer, not using air conditioning, etc.)*

And finally I'd like you to reflect on other households with the same number of people who live in homes similar to the size of yours, but who use *more* electricity than your household.

7. Without knowing how these folks use more electricity, can you think of any recommendations you would give them? What might you suggest they do to reduce their electricity use?

That completes our survey. We greatly appreciate your time and cooperation. Thank you very much for your answers to our questions. Do you have any additional comments or questions for me?